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# ELECTRICAL REVIEW.

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THE

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## THE OPERATION OF ELECTRIC TRAINS.

THE operation of an electric railway, as distinct from an electric tramway, brings a new set of conditions into existence, and probably this is better realised to-day than it was 10 or 12 years ago, before the economy and efficiency of electrically propelled tramcars had been demonstrated.

When electricity was first employed for working a railway service, it was not surprising that the locomotive system should have been followed, and for sentimental reasons an electric train with a locomotive in front appeals more to one's sympathies than two or three cars gliding along without any perceptible source of motive power. The most conspicuous instances of trains operated by electric locomotives are on the City and South London Railway and on the Baltimore and Ohio Railway, and in neither of these cases could it be said that the system had not achieved a most striking success.

The later practice in electric train services has been in the direction of employing one or more cars fitted with electric motors, the control and development of the power, however, coming from one car, according to the direction in which the train is travelling. The disadvantages of such a system were not very obvious where the trains were specially made to meet the new conditions, and where, as a rule, lighter vehicles and shorter trains were used than would be generally employed on a steam railway. When, however, the necessity arose of converting existing steam lines into electric, the current systems of electrical operation were somewhat at a disadvantage. We believe we are correct in saying that the experiments that are being conducted on behalf of the Metropolitan and District Railway Companies to test the applicability of electricity to railway working, are on the lines of previous electric railway practice in this country. It is doubtful, however, if such experiments will be conclusive as regards the economy and efficiency of electrical working. It would have been distinctly interesting, and the chances of success might have been greater, if a system similar to that of Mr. Sprague's (which is now known as the multiple unit system) were employed. Reference has been occasionally made in these columns to the principal features of this method, and doubtless many of our readers are familiar with them. A train on such a system would be made up of a number of independent cars, each of which would be completely equipped with motors and controlling apparatus. The conditions fulfilled by such a train would be the simultaneous control of two or more independently equipped motor cars, to start, accelerate, and operate at any speed up to their maximum, to slow down and apply automatic brakes, all with practically uniform effect in each and every motor car.

One of the most striking advantages possessed by such an arrangement is the possibility of shortening or lengthening the train to any reasonable extent without affecting the time of the service. One can hardly help speculating

on the losses that must arise on most of our suburban lines during periods of light loads. On the Metropolitan Railway one sees during certain portions of the day trains passing backwards and forwards comparatively empty, and probably the whole of the passengers could be, without inconvenience, p'aced in one car. At other times trains are inconveniently crowded, and doubtless the enormous rush, necessitating long trains and heavy loads, means unpunctual service. An electrical railway employing a multiple unit system would be able to add cars up to the capacity of the platforms, and there ought not to be the slightest falling off in speed. In other words, as Mr. Sprague has already pointed out, such a system gives any required rate of acceleration or schedule speed up to the maximum, thus giving the highest schedule with any given maximum, and the lowest maximum with any given schedule. Necessarily the distribution of the driving power throughout the train needs a less weighty driver than would be required if a separate locomotive were employed, and this fact, to some extent, affects the question of bridges and overhead structures. Although the system, so far as theory is concerned, has been well known for some years, it is only within the last two years that it has been practically adopted in actual railway practice. In 1897 the Chicago Elevated Railway adopted the system on the advice of Mr. Sprague, and one of the conditions that had to be met was, that the method of control was to be such that any number of cars so equipped could be coupled together indiscriminately without regard to their sequence; and, when so coupled, by identically the same movement, they were to be controlled from any selected point, at either end of any car, and the rate of acceleration, traction coefficients, speed, and braking conditions which characterise a single car were to be retained in a train unit no matter what the number of cars. At the present moment some 120 motor cars are employed on this line, and, judging only by the financial results, the system merits the most careful consideration on this side of the Atlantic. Taking two comparable periods, the difference in cost is most striking. In the case of steam the ratio of expenses to earnings, including taxes and licenses, amounted to 73·8 per cent., while in the case of electricity, the ratio of expenses to earnings was 45·4, and the total operating expenses per car mile, excluding taxes and rental, were less than 3½d. Although we are aware of the difficulty of making comparisons between this instance and similar lines in this country, it is very interesting to see how the cost of operation compares. The Liverpool Overhead line in the year ending 1897 had a ratio of expenditure to revenue of 65·54 per cent. On the City and South London Railway the working expenses were 56 18. One has to remember that these lines have the disadvantage of being much older systems, and doubtless they might even with similar plant show better results if they were designed to-day. The objection to the multiple system is that the method of control must necessarily need a somewhat complicated apparatus, and a certain amount of skill and care in connecting up and disconnecting separate units. We do not, however, look upon such a difficulty as insurmountable, and it has to be borne in mind that main currents are not carried from car to car, but the electrical connections are necessary only for carrying small currents. Naturally such an arrangement as the multiple unit means smaller motors for cars and a greater space on the car trucks; at the same time a distinct disadvantage is that every car is in a sense a locomotive, and a rigid inspection is necessary for every vehicle. We should imagine that repairs might occasionally figure largely; on the other hand, if a car breaks down it affects merely itself, and does not dislocate any other unit. It is difficult to realise that a multiple unit system would be less in first cost than a train drawn by an electric locomotive, though the special work on the locomotive might more than compensate for equipping every car with electrical apparatus. At any rate, the system has to-day reached such a state that no engineer responsible for the design of an electric railway can neglect it.

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Luminous Rings in Rarefied Gases.

The physicists of late have been much engaged in reviewing the achievements of their science during the century about to expire. They find that a few simple laboratory experiments, not considered to be of much account by contemporaries, have turned out in after years to have been the beginning of great revolutions in theoretical science or industry. Hence, perhaps, the marked tendency among the speakers at the British Association meetings to discover in every little novelty presented to their section the beginning of a revolution which is to change everything in the coming century. To the plain man there do not appear to have been many of the Volta, Davy, Faraday or Maxwell type at the Dover meeting. One exceedingly interesting experiment, however, was shown by Mr. C. E. S. Phillips. A glass bulb was fitted with two iron electrodes which projected into the tube till they nearly met in the centre. The tube was exhausted, and a discharge from an induction coil passed between the electrodes for a short time. The coil was then disconnected, and an electro-magnet applied to the electrodes so as to produce a strong magnetic field between the adjacent ends of the iron electrodes. Immediately a luminous ring appeared with its plane at right angles to the axis of the electrodes, and rotating about this axis. This ring was found to be negatively electrified. The plane of the rotation of the ring changes with the direction in which the exciting discharge is sent through the tube. The best explanation of this curious phenomenon given is that the rarefied air in the tube is dissociated by the discharge into positive and negative ions. The negative ions have been shown by J. J. Thomson to be much more mobile than the positive ions, and they are consequently set in rotation by the action of the changing magnetic field while the positive ions remain comparatively quiescent. Mr. Phillips deserves much credit for his highly interesting and original discovery.

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**A Third Class of Electrode.**—Robert Luther has designed a form of cell in which there is obtained a reversible electrode of a metal which decomposes water, as, for example, the following: Lead in a mixture of calcium and lead sulphates in a solution of a calcium salt. In this case the potential difference at the electrode is $\pi = K \log. k_2/(Pb'')$, but $(Pb'') \times (SO_4'') = k_1$ and $(Ca'') \times (SO_4'') = k_2$; hence $\pi = K \log. k_2/(Ca'')$. The availability of such a form of electrode is proved by the determination of the E.M.F. of chains containing such electrodes of zinc with those containing ordinary electrodes, the values only differed by 0·001 volt. It is evident that the salts employed must be only slightly soluble, and must form no double compounds or mixed crystals. For further details consult *Zeitschrift für Physikalische Chemie*, Vol. 28, pp. 364—366.

## THE INTERNATIONALISATION OF SCIENCE.

The hearty reception which was given to the deputation of the French Association for the Advancement of Science which crossed the Channel early on Saturday morning last to attend the Dover British Association meeting, showed in a very conclusive manner that the narrowmindedness which has been recently evinced by newspaper writers and others over *l'affaire Dreyfus* obtains no sympathy or sanction from the sincere searcher after truth.

We have no doubt that every Englishman present at Dover was profoundly convinced of the guiltlessness of the most modern of French martyrs and the corruption existing among higher officials of the Republic of Liberty; but we have as yet failed to find in these conditions a reason for a rupture between scientific men of the two nations. Although science may do great things to help in the furtherance of the cause of peace, we hope that the day is far distant when political or like differences or disturbances will be allowed to interfere with the cordial relations existing between scientists all the world over. Science should be international, wide as the world, nay, it should be a nation of itself, a nation within nations. We showed to our cross-channel *confrères* on Saturday that whatever untoward events, to use the term of Sir Michael Foster in his presidential address, may rock a people in a turbulent sea of strife, they are without the sphere of science.

The question of next year's Paris Exhibition is one requiring more thought before it can be settled to our satisfaction. It must be calmly considered with slow deliberation. We do not intend to proclaim to the world at large that we shall boycott all electrical exhibitors who take part, and that we shall devote many columns to a description of the work of those who do not. This may be considered a wise stroke of policy for a contemporary, but we think it is a policy which should not have been proclaimed upon the house tops with the precipitancy which seems to have characterised it. Furthermore, it is not a policy which will be adopted by the Electrical Review, for we shall endeavour to see that *l'affaire* is not allowed to control in any way whatsoever the policy of a journal aiming to be a record of electrical science and its progress. We have other like feelings on this matter, but we will not write them—we will merely remark that the questionable policy of boycotting is by no means confined to journalists; it might prove to be a policy to turn and rend one.

Returning to the French visit, Section A mainly interests us. The meeting of the Association, as a whole, has been very poorly attended, as we indicated last week, and the proceedings without any particular excitement; but the monotony of A was certainly relieved by the discourse of Prof. J. J. Thomson "On the Existence of Masses Smaller than the Atoms," with its subsequent discussion, and the discourse of Dr. Oliver Lodge "On the Controversy Concerning the Seat of Volta's Contact Force," which had to be somewhat curtailed owing to the want of time. These addresses formed part of the arrangements made specially in honour of the French visit, and that of Prof. Thomson was followed by several speeches of welcome, worded in the most felicitous terms, as well as some remarks by Sir Norman Lockyer upon his work in the particular field of research which formed the subject of the lecture.

Sir George Stokes said he wished to show how cordially Section A welcomed their friends of the Sister Association across the Channel. The interchange of visits with its interchange of ideas—both associations alike being engaged in the search for truth which is common to the whole world—tended to draw together the heart of the two nations as well as to sharpen the intellects of the individual, and therefore tended not only to the promotion of knowledge, but to the cause of peace and brotherly kindness between different nations. After a few words from Sir George on the subject of the discourse, Prof. Rucker, in his official capacity as secretary of the Royal Society, made some remarks to welcome their French colleagues. He said that it was very curious how the tendency towards internationalisation of science was gaining strength day by day. It had fallen to his lot as secretary to the Royal Society to already attend this year one international meeting in which the great scheme for an international catalogue of scientific literature was discussed. It need hardly be said that a scheme so great was surrounded by difficulties, nevertheless there was a reasonable hope that an agreement would be come to which would help to the publication of such a work at the dawn of the new century. It had further fallen to his lot to go to Wiesbaden to meet German, Italian, and other friends to discuss the question of forming a union between the scientific academies of the world. Should this be carried out, and all those bodies put themselves into touch with one another, they would have reached that state of things in which they had an international court of arbitration to which disputes could be referred, and, further, a body which could discuss on scientific grounds questions of scientific interest. They would then be able to give to their various Governments, not simply the ideas of an individual or country, but well thought out and discussed ideas of the united science of the world.

Prof. Barker, of Philadelphia, after joining with previous speakers in the expression of admiration of Prof. Thomson's paper, said that he had not the right to welcome them to Dover, but the Atlantic was in a few years to be a channel, and they in America hoped to have the pleasure not only of welcoming the French Association in that free and easy and delightful way, but the British Association as well. The suggestiveness was that the time was coming when they would be able to leave America in the morning, to attend the sections of the B.A. through the day, and go home at night. They in America would extend to them all the hospitality which their continent contained, and if it was not big enough "we will put on some more."

Dr. Oliver Lodge found it difficult to get away from the fascinating subject of Prof. Thomson's address, but after a few comments regarding same he proceeded with his address on the "Seat of Volta's Contact Force." When asked to say something on the occasion of the French visit, he remembered that this year the world was celebrating the centenary of that great Italian physicist, Volta. One hundred years ago Volta discovered the electric current. He discovered two facts—(1) that an electric current would be produced when two metals touched each other under liquid, and (2) that two electric charges are produced when two metals touched each other in a dielectric. It was strange, he said, that 100 years afterwards the explanation of those simple facts was not even now complete. It was strange that a controversy had raged around the subject with greater or less vehemence all the time, and last year, or the year before, was resuscitated by Lord Kelvin. He regretted the absence of Lord Kelvin, as he took directly opposite views to his lordship on some points. He then proceeded, by the aid of blackboard diagrams, to explain what were the three facts which Volta discovered, and showed the points of difference between his own and Lord Kelvin's views. In bringing his discourse to a premature conclusion, Dr. Lodge indicated that it was his intention to shortly pursue the subject further before the Physical Society of London.

## ELEMENTARY TREATMENTS OF ALTERNATING CURRENT PROBLEMS.

By W. G. RHODES, M.Sc., M.I.E.E.

The transition from direct current to alternating current problems is generally regarded by electrical students with a certain, and often abnormal, amount of fear and trembling; and if we look for the cause of this awe and reverence in which the subject of alternating currents is held by the great majority, we shall, I think, find that the fault is not altogether the students'.

A casual glance at any standard book on the subject is sufficient to show that unless the fundamental notions can be expressed more simply the student, whose mathematical attainments are of a limited nature, cannot hope to gather more than a hazy idea, and he certainly cannot learn enough to enable him to make use of his knowledge in a workshop or laboratory.

There appear to be two types of writers. The first class

smaller motors for cars and a greater space on the car

*Zeitschrift für Physikalische Chemie*, Vol. 28, pp. 864—866.



is composed of the few who, by the aid of powerful mathematical analysis, can occasionally hit upon a new result or place an old result in a new and perhaps more interesting form. The second class comprises those whose sole aim is not to cater for the highest intellects but who rather desire to bring the salient points of the subject within the reach and understanding of less cultured minds. The abstruse writer provides only for those of his own class, or, perhaps I had better say, for the favoured few who, thanks to an academic training, are able to follow difficult mathematical demonstrations, and to whom the mathematics is often a greater attraction than the physical bearing of the problem. I do not wish to under-rate the value of the higher mathematics, because it is in a few cases absolutely necessary, but its use where unnecessary is pedantic and selfish. The mass of electrical readers who contribute most towards the advancement of electricity in its applications to commerce must be provided for, and the writer who by simple and at the same time accurate explanations can convey the fundamental principles of alternating currents to the non-mathematical mind, and show the application of those principles in the alternator, transformer, induction motor and such like machinery is of very great use indeed. Unless these principles can be accurately conveyed to those whose daily occupation it is to manufacture the machines, we cannot hope to make adequate headway.

The engineering workshop is the place from which ought to emanate improvements of all kinds of machinery. It is in the actual manufacture of a machine that the need of improvement becomes evident, and the makers of any type of machine are the most likely people to effect the improvements if only they understand thoroughly the underlying principles. The day of the *trial and error* process is fast becoming out of date. The only way now open is, having discovered a deficiency, to think out the true remedy and then apply it with a sure and certain knowledge that it must effect a cure.

The manufacturer is unjust to himself if all that he can do is to find out the defect, and he is compelled to go to someone else to find the remedy. When the ability is there it is often a matter of greater difficulty to find the defect than to ascertain the remedy.

Now, I am persuaded that in most cases mechanical and electrical problems can be approximately solved without the aid of abstruse mathematical calculations.

If a good mental picture of the physical processes involved in the working of a machine is formed, it is better than all elaborate calculations. It was by means of mental pictures of lines of force that Faraday was enabled to perform those experiments which have led to the development of the modern dynamo.

This method of mental and graphic representation is the one which ought to form the basis of every physical study, and the most successful teacher is he who forces upon his students a physical conception of the subject—accentuated by experiment — before attempting to make quantitative calculations. He should only regard mathematics as a set of tools, some of which demand greater skill for use than others, and the rule should be never to use skilled labour when unskilled serves the purpose equally well.

No one would dream of using a steam hammer to drive in a tack, but many would require the use of the calculus to determine the maximum power which a generator of given E.M.F. and internal resistance could give to an external circuit. Why should almost every writer on alternating currents perform an integration to determine the mean power given to a reactive circuit when the result can be arrived at by means of elementary trigonometry? One could multiply such examples almost indefinitely, citing cases in which it is customary to use more difficult methods than are necessary for the solution of simple practical problems.

Simple symbolic reasoning is, if not necessary, at any rate very helpful, but it is always easier to attain results if the whole attention can be concentrated upon the conception of the problem. It is much easier to grasp a subject if written in English than in any other language, because the whole attention is given to the idea, and is not distracted by turning to a dictionary to find the meaning of certain words.

It is the same with alternating currents. If the whole attention could be concentrated upon the conception of the periodically variable quantities without the expenditure of any appreciable thought on the mathematical processes, how much easier it would be! Most electrical engineers are conversant with the elements of algebra and trigonometry, but few have carried their mathematical studies much further. To bring alternating current literature within their reach it is necessary, therefore, to use no more of the higher mathematics than is absolutely necessary, and whenever results cannot be obtained by elementary means they should be stated clearly and succinctly.

I have a small book before me by M. O. De Bast, entitled "Elementary Research on the relations between Electrical Quantities in Alternating Current Circuits," upon which the author must have spent much time in endeavouring to express his thoughts in the simplest possible manner. Not a single application of the calculus is to be found in the whole book, and yet problems concerning circuits containing inductance and capacity are considered, as well as an extremely interesting treatment of polyphase circuits. It is to be hoped that an English translation will quickly be obtainable; it should attract the attention of non-mathematical readers. The idea which pervades the whole book is to place physical conceptions prominently before the reader, and to use only simple mathematics where necessary.

## THE BRITISH ASSOCIATION.

Of recent years the annual gatherings of the British Association for the Advancement of Science have been regarded as a series of more or less scientific entertainments on a large scale, or one great picnic party whose festive and social proceedings were interspersed with snatches of science. The series of meetings which have just been brought to a conclusion at Dover have tended to confirm rather than to weaken that view. It has been stated in several quarters that the weather would to a large extent decide for or against the success of the meetings on account of the large number of social events, visits to places of interest, &c., forming part of the programme. We imagine that socially considered there is little room for disappointment in spite of a thunderstorm, and it is very probable that in certain sections the papers and discussions were of value, but we have some hesitation in saying whether, from an electrical point of view, the proceedings may be considered satisfactory. We do not like to write the word "failure," but we will leave our readers to form their own opinion from the list of the papers, &c., which we publish further on, and from the reports or abstracts thereof appearing in our other columns.

The Mechanical Science Section (G) was exceedingly fortunate in having so able a president as Sir Wm. H. White, the chief constructor to the Admiralty, whose very wide knowledge and experience proved of great value in the several discussions—in fact, we might almost say that he was the heart and soul of the discussions. What he said was always of interest, whether it was on the Niclausse boiler, the Parsons turbine, the use of electricity on shipboard, or any other subject.

In the course of the discussion on the paper contributed by the Hon. Mr. Parsons on "Fast-speed Channel Steamers," Sir W. H. White said that he had had a most complete knowledge of Mr. Parsons' invention ever since he began to work upon it, and only those who possessed such complete knowledge could know the many difficulties which he had faced and conquered in bringing into practical shape this individual type of propelling machine. It was a record of which any man might be proud. Prof. Dunkerley, who had assisted Prof. Ewing in tests made 2½ years ago off the Tyne, said that at the time he was considerably prejudiced against the turbine system as regards marine propulsion, but eight or ten days under continuous trial under all possible conditions, speeds, &c., quite convinced him as regards the usefulness of the particular engine. Now he was merely waiting for the time when the very crude contrivance which they called the reciprocating engine, would be a thing of the past. Anyone who had been on the *Turbinia* would have remarked the extreme absence of vibration, the absolute ease with which the turbine was manipulated, and the extreme rapidity with which full pressure steam could be placed on the engine in time of emergency. On the *Turbinia* there was no reversing engine, but Mr. Parsons had now shown that the difficulty had been overcome. In regard to the consumption of this engine.—The steam turbine, as applied to electrical purposes, had, of course, been frequently tested, and those tests showed, he thought, that 15 lbs. of steam per I.H.P. per hour was

about what might be expected from them. He noticed that Mr. Parsons gave as a result of the *Turbinia* 14½ lbs. per I.H.P. per hour. In such engines the I.H.P. could only be obtained inferentially, and he took it that that had been done by Mr. Parsons. He asked, could Mr. Parsons tell them what was the steam consumption per effective H.P., not per I.H.P.? Mr. Parsons replied that it was 28½ lbs. After further comments from Prof. Dunkerley, another speaker said that Mr. Parsons had adopted the true principle of the rotary engine. They had had hundreds of patents for rotary engines, but 99 out of every 100 were reciprocating engines in a compact form. The speaker asked whether, as the I.H.P. had only been obtained inferentially, the author could tell them of practical methods of finding absolutely the I.H.P. either by measuring the thrust on the screw shafts, or by other means which might have suggested themselves to his mind, because, as soon as they brought this engine into use, they would want ready methods of finding actually the I.H.P. without trusting to inferential methods. Sir E. Carbutt said that they all had had a prejudice against this class of engine, because it swallowed a large amount of steam. But Mr. Parsons had had this engine in electric lighting stations for 10 years, and he ought to be able to give them some figures of consumption for work done, say, per unit of electricity. If he could give some standard to compare it with ordinary reciprocating engines, then they might be able to find out whether it would be a fuel consumer, or whether a good deal of work was being got out of it. If he could give them those figures per pound of fuel, showing what he did in electrical stations, it might enable them to form a judgment.

Mr. Barker, the engineer-in-charge of the Cambridge electricity works, said that he had had charge of 15 steam turbines of 1,000 H.P. for six years. He could speak with certainty first of all as to their great endurance. He ran the 120-KW. set for a whole year. Not one penny had been spent upon up-keep, and at the end of the time to all intents and purposes the engine was in as good a state as on the first day of the run. Another engine for the three winter months ran for 20 hours a day with exactly the same oil, it turned 600,000,000 revolutions, and at the end of that time they could not detect any appreciable depreciation in any respect. Bearing tubes had been put in to the best of his knowledge and belief. One which came down with the engine six years ago was still in use. For a meeting in London he moved two tubes at the end of four years, and they were then in an absolutely good condition. Unfortunately all the tabulated statistics of electric lighting stations were made on the basis of so many pence per unit for coal per unit sold. Cambridge stood next to Dover, where coal was the most expensive of any station known. There was an initial charge of something like 7s. per ton to be paid for carriage, &c. In all the returns made of the Cambridge station there was not a single word said about this. The cost of coal per unit sold was 3d. at Leeds. At Cambridge it was very nearly 1d. He had no ordinary engine at the works; they were all turbines, so that they could not get the credit of any other engine. The president intimated, in reply to questions by Sir E. Carbutt, that Mr. Parsons would be able to give a comparison under the same conditions of machinery on the two systems.

Another speaker, hailing from the Scarborough electricity works, said he could confirm the statements of the previous speaker from experience at Scarborough. Although coal was rather expensive there, they had no reason to complain.

Mr. Parsons, in the course of his reply, intimated that the indicated dynamometer tests of turbines had been made by Dugald Clerk six years ago, and resulted in figures which formed a basis on which they could make an exact estimate of the steam consumption per B.H.P., and the dynamo efficiency was within 2 or 3 per cent. On that basis the steam efficiency of the turbines up to 900 H.P. had been estimated with the greatest accuracy, and the best result was about 16 or 17 lbs. per B.H.P., which was about 15 lbs. per I.H.P. An exact comparison had been made in regard to coal consumption between the Newcastle companies. The coal per KW. in the two stations was almost indentical, almost within 1 per cent. One station had compound rotary engines by Robey, and Brush dynamos, and the other had turbines. Both stations used Lancashire boilers. The consumption was about three times what it ought to be, 7 to 10 lbs. of coal per H.P.

After the thanks of the section had been accorded to Mr. Parsons, Mr. Mark Robinson's paper on the "Niclausse Water-tube Boiler" was read and discussed. We refer to this in our "Notes" columns.

The paper of Mr. Alexander Siemens on "The Use of Electrical Machinery on Shipboard," which we shall publish next week, gave rise to a discussion, and Sir Wm. White's comments on the extent of the adoption of electricity in H.M. warships, &c., for lighting and power purposes, which may be regarded as those of the Admiralty department, were exceedingly interesting. We hope to refer to them next week.

The joint paper by Prof. W. F. Barrett and Mr. W. Brown on "The Electric Conductivity and Magnetic Properties of an Extensive Series of Alloys of Iron, prepared by Mr. R. A. Hadfield," we may hope to have the pleasure of dealing with at a later date. The very extensive research forming the subject of the paper has produced certain results which add to our knowledge of the electrical conductivity and magnetic properties of various iron alloys. Prof. Hudson Beare intimated to the section that he was making mechanical tests of the alloys for Mr. Hadfield, and it was thought by some who were present that these would be of considerable value when available.

The following is a list of the electrical papers and reports :—

SECTION A.

Prof. H. L. Callendar, F.R.S., and H. T. Barnes—Preliminary Note on the Variation of the Specific Heat of Water.
T. G. Bedford—On the Expansion of Porcelain with Rise of Temperature.
Report on Methods of Determining Magnetic Force at Sea. (The report simply stated that there was nothing new to report.)
Report on Electrolysis and Electro-Chemistry.
Prof. W. F. Barrett, F.R.S.—On some Novel Thermo-Electric Phenomena.
Report on Radiation from a Source of Light in a Magnetic Field.
C. E. S. Phillips—On the Production, in Rarefied Gases, of Luminous Rings in Rotation about Lines of Magnetic Force.
E. H. Griffiths, F.R.S.—Note on a Form of Wheatstone's Bridge.
Prof. J. A. Fleming, F.R.S.—A Workshop Form of Resistance Balance.
Dr. R. A. Lehfeldt.—On the Theory of the Electrolytic Solution Pressure.
Report of the Committee on Electrical Standards.
Prof. J. J. Thomson, F.R.S.—On the Existence of Masses smaller than the Atoms.
Prof. Oliver Lodge, F.R.S.—On the Controversy Concerning the Seat of Volta's Contact Force.
Report on Seismology.
Dr. L. A. Bauer—On Recent Magnetic Work in North America.
Discussion—On Platinum Thermometry, introduced by Prof. Callendar.

SECTION G.

Hon. C. A. Parsons, F.R.S.—On Fast Cross-Channel Steamers driven by Steam Turbines.
Mark Robinson, M.Inst.C.E.—The Niclausse Water-tube Boiler.
A. Siemens, M.Inst.C.E.—Electrical Machinery on Board Ship.
Prof. W. F. Barrett, F.R.S., and W. Brown, B.Sc.—On the Electric Conductivity and Magnetic Properties of an Extensive Series of Alloys of Iron, prepared by Mr. R. A. Hadfield.
Sherard Cowper-Cowles, Assoc.M.Inst.C.E.—Some Recent Applications of Electro-Metallurgy to Mechanical Engineering.
Wilfred S. Boult, Assoc.M.Inst.C.E.—Signalling Without Contact, a New System of Railway Signalling.

In other sections there were papers on "The Development of Chemistry in the last 15 years," by Prof. A. Ladenburg; Dr. G. Schott on "Oceanographical and Meteorological Results of the German Deep-Sea Expedition in ss. *Valdivia*" (this paper contained, among other things, some very brief references to deep-sea soundings in connection with submarine cable work, and noted the great advantages obtained by employing electric motors for operating sounding apparatus); Prof. H. E. Armstrong on "A Peculiarity in the Behaviour of Electrolysed Sulphuric Acid"; Mr. R. Donald on "Municipal Trading"; Prof. Dewar on "The Solidification of Hydrogen"; and a report on the electrical changes accompanying the discharge of the respiratory centre. The paper which had been announced on "Electric Tramway Earth Currents," by Mr. J. Swinburne, was not read. Mr. Thorneycroft dealt with "Steam Traction on Common Roads" in Section G, on Tuesday.

On Monday evening Prof. Fleming delivered a lecture in the Dover Town Hall on "The Centenary of the Electric Current and Wireless Telegraphy." He explained that the object of his lecture was, by a few experimental demonstrations, to direct the attention of his audience to consider the main conclusions reached after a century of investigation on this matter, and to indicate the problems which yet remained to be solved. After an exhaustive review of the discovery and development of the electric current, he said these principles had received their most logical extension and completion in the evolution of the electro-magnetic wave telegraphy, which Signor Marconi had developed on such a large scale in the last few years. In order to illustrate and explain the working of the Marconi system of wireless telegraphy, the complete apparatus was established on the lecture table. During the progress of the lecture messages were despatched to the South Foreland and to Wimereux, and replies received. The recent application of electricity to a method of steering self-moving torpedoes by means of an electric spark and sensitive powder tube was mentioned, and it was demonstrated that explosives could be fired by electric waves without wires. Some remarks followed as to the nature of the electric current.

A wireless message was despatched to Boulogne for re-transmission to Como, where the centenary of the work of Volta was being celebrated, and a reply received, another message being sent to the French Association meeting at Boulogne.

On Tuesday there was an important discussion opened by Prof. Callendar, F.R.S, on "Platinum Thermometry," the speakers including Dr. J. A. Harker, Dr. Chappuis, Mr. E. H. Griffiths, Profs. Carey-Foster, Burstall and Threlfall, and Principal Glazebrook and others.

The electric tramway service at Dover was very fully appreciated by the members of the Association, who made good use of it, the cars being each day crowded during the greater part of the morning and afternoon. The only fault one has to find with the system is the very long stoppages which occur at the single line passing places. But this, we suppose, is unavoidable on account of the narrowness of the thoroughfares and the frequency of curves.

### President's Address in Section G.

An address such as that of Sir Wm. White is useful as marking time on the progress of mechanical engineering. One of the chief things dwelt upon was the size and power of steam vessels, some comparisons being made of the increase in dimensions during the past 60 years. In 1840 the Cunarder *Britannia* had a speed of 8½ knots, carried 12 lbs. pressure, was 207 feet long, and 2,000 tons displacement with 750 H.P. She burned 40 tons per day, or 5 lbs. per H.P.-hour. To-day the *Oceanic* displaces 25,000 tons, is 685 feet long, and does 22 knots. We believe the power is over 40,000. Ships have nearly trebled their speed, more than trebled their length, increased tenfold in displacement, forty-fold in engine power, quadrupled their H.P. per ton driven, and reduced their coal per H.P. to one-third. In 1840 one ton of machinery produced 2 H.P.; to-day it produces 6 to 7 H.P. Greater draught is needed; this has been kept comparatively small by port facilities and shallow Suez canals.

Curiously enough, the first Channel steamer was built in 1821 by Denny, of Dumbarton, the ancestors of the present firm of famous shipbuilders. The President did not touch much on water-tube boilers, excepting as regards torpedo boats, the boilers of which we consider far ahead of those of our large cruisers.

He did, however, refer to the steam turbine, the high speed of which enables weight to be so much reduced.

Thus the *Turbinia*, only 100 feet long and 44½ displacement, has run at 34 knots with three propellers at 2,000 revolutions, making 2,000 H.P. with steam at 175 lbs. About 100 H.P. is produced from each ton of propelling apparatus, or double the output of the lightest machinery in torpedo boats yet made: Mr. Parsons claims equal economy with the triple-expansion engine. Two destroyers are now preparing for driving by turbines; 10,000 H.P. is anticipated, so the experiment is not small. But we see no reason to doubt the success of the steam turbine on any power, and if at large powers Mr. Parsons is still successful with small propellers he will have done good service.

Further reduction in machinery weights and hulls, and improved forms of hull and larger dimensions with greater draughts, are the factors concerned in securing better speeds, but in large vessels increase can only be slow. Unlike the small vessel the large vessel must reach 47 knots before the reduced resistance comes into play, which holds at 30 knots for small vessels like torpedo boats.

It appears that Mr. Parsons considers he could reduce by one half the weight of the engines and propellers of a liner by the use of his turbine. Liquid fuel also could effect probably a saving of 1,000 tons of weight on a first-class Atlantic liner. But liquid fuel is not yet found in anything like the necessary quantity for such use. As regards material, 1,000 tons of load could perhaps be saved by nickel steel in place of mild steel. Generally, the experience of the past will be reproduced in the future if at a less rapid rate.

Probably the *Oceanic*, just sent out on her first voyage and intended to run to time, may mark a halt for a time until higher speeds can be made with the same punctuality. With an Atlantic liner arriving to a printed time table, we may even look forward to a London suburban train arriving within an hour of its time. We would not, of course, venture yet to include the South Eastern and its partner in sin.

A sound steamship of large size seems to take very little notice of weather, its perils coming chiefly in regard to collisions or from internal causes. Waves hardly affect the largest steamers.

## ELECTRIC TRACTION PROGRESS IN THE NORTH.

It may be said without much fear of contradiction that at the moment the principal seat of progress in electric traction lies in the North. It is true that Newcastle, among other places, has achieved considerable notoriety by exhibiting a spirit of vacillation; but when it is considered that Manchester, Sheffield, Leeds, Glasgow, Blackpool, Bradford, and Hull are either provided with or have decided to adopt an extensive system of tramways, it will be seen that matters have progressed much more rapidly in the Northern counties than in the South of England. It is not easy to account for the difference between the two parts of the country, unless it arises from the greater enterprise in the Northern municipalities, for it must be remembered that electric tramway schemes in the North are being carried on almost entirely by the local authorities. We are promised something exceptional in the way of electric tramways by the London County Council, but apart from this instance electric tramways in the South of England will be carried out mainly by companies. A special instance of the spirit of progress exhibited by Northern municipalities is that of Sunderland, which has embarked upon a scheme of tramways involving a capital expenditure of £250,000. It is an interesting sign of the times that Corporations, after following a somewhat slow policy in regard to electric lighting extensions, should in adopting electric tramways be prepared to pledge the capital of the ratepayers to such a large extent. While one cannot help rejoicing at this, it is to be sincerely hoped that municipalities will not, in developing electric tramways, forget the almost paramount claims possessed by electric lighting.

Unlike its near neighbour Newcastle, the Corporation of Sunderland has arrived at its present scheme of electric tramways with very little delay, and doubtless this in a measure arises from the very admirable and complete reports on the subject of electric tramways that have been issued from time to time by the Corporation. While other towns have been considering the merits of the various systems of electric tramways, a Sunderland deputation went to work and not only obtained valuable information regarding the operation and control of electric systems, but they also made careful inquiries into the operation of surface contact and conduit systems. The system, which is to be carried out in Sunderland, will include some 23 miles of electrically operated lines, and these will be made up of the original lines owned by the local tramway company, and an entirely new system which will be laid down by the municipality. The lines owned by the tramway company were not extensive, being, in fact, hardly 4 miles in length. The Town Council, availing itself of its powers under the Tramways Act, will obtain possession of this system for a sum of £35,000, although the total expenditure of the company up to December, 1898, had amounted to £74,281. It may be remembered that a large contract in connection with the Sunderland tramways has been given to Messrs. Dick, Kerr & Co., but although this contract relates to the reconstruction of the existing lines which are now worked by horse traction, and to the construction of a new route, it only forms a little more than half of the entire system which is to be carried out by the Corporation. Certain portions of the track are to be laid by Christmas, but apparently it is not expected that electricity will be in use before June because provision has been made for working most of the new lines by means of horse traction. It may be expected that the contracts will be completed by June 30th next year, but probably the difficulty of completing orders will result in a little delay; moreover, it has to be remembered that the Town Council is allowed five years in which to complete the whole of the electrical scheme. One of the most difficult matters in connection with electric tramways is to obtain authentic figures as to the cost of operation, but the difficulties which have hitherto existed with regard to this are not likely to be present in the case of the tramways operated and controlled by a municipality, for the statutory returns which a local authority is compelled to make, will enable one to form an adequate opinion as to what it really costs to operate an electric line. The expectations of the Sunderland Corporation with regard to the

working of the system are fairly moderate, and it is assumed that the annual working expenses for 22·77 street miles, including sinking fund and interest on total capital expenditure, the cost of purchasing the company's undertaking, and sinking fund and interest on existing Corporation lines will be £38,778, while the annual receipts are expected to be £47,844. It is fully anticipated that the working expenses will be covered if 6,997,532 passengers are carried in a year, or, 19,166 per day. The estimates show that 23,648 passengers are expected to be carried every day, or, 8,633,479 per annum, which would yield an annual profit of some £9,666. In the light of experience gained at Stockton and Middlesbrough, the foregoing is an exceedingly moderate estimate, but we believe that one of the most significant causes of success in the operation of electric tramways is a frequent and rapid service. In the case of Middlesbrough and Stockton an exceedingly bold course was adopted in regard to service, and, if we are not mistaken, the headway between the cars on the Stockton line does not average more than one minute; the success achieved on these lines is all the more remarkable, because it was felt by many authorities that electricity would not be economical if a quicker service than one of five minutes were adopted. The operation of the New York line, however, modified many opinions on this subject, and at the present moment it is most difficult to ascertain what is the real limit of an economical service.

## THE ELECTRICAL ENGINEERS' SWISS TOUR.

The first annual meeting of the Institution, held in the most auspicious circumstances, has by common consent been voted an unqualified success. No less than 140 members, and 17 ladies, took part in the reunion—a company of quite unexpected dimensions, and which no organisation less perfect than that of Messrs. Cook could have piloted through its wanderings without disaster. Amongst those who were present we noticed the President and Mrs. Thompson, Prof. Perry (vice-president), Mr. Crompton (past-president), Messrs. Fawcus, Hammond, Mordey, Sellon, and Campbell Swinton (members of council), and many other distinguished members of the Institution. Many of the visitors took advantage of the early start on Thursday evening, August 31st, and enjoyed a night's rest at Bâle before commencing the hard work of sight-seeing; but the majority travelled by the later train on Friday morning, and arrived at Bâle at 6 o'clock on Saturday. No time was lost in getting to business, as we set out for Rheinfelden soon after 8 a.m.! At an early stage the discovery was made that the language favoured by the popular taste was a form of German, which put most of the party at a disadvantage; strenuous efforts were made by Mr. Rolph, the indefatigable assistant secretary, and other interpreters, to surmount the difficulty, but as a matter of fact the machinery and works spoke for themselves, far more eloquently than any human tongue.

The magnificent display of generating plant of 16,800 H.P. was most impressive, and formed an excellent introduction to the sights that were to follow.

After spending several hours on the station and the hydraulic works connected therewith, the party proceeded on foot, through picturesque surroundings, to an hotel in the village of Rheinfelden, where the directors of the works had provided an excellent luncheon. Light refreshments were handed round in the garden, in the short interval of waiting, to those members of the party who wore the badges thoughtfully furnished by the committee; many members who had previously worn these in their pockets, perhaps from natural modesty, were now observed to don them somewhat hurriedly.

During luncheon, according to the local custom, short speeches were delivered; the first speaker was Dr. Frey, the general manager of the works, who said:—

Honoured ladies and gentlemen!—The Company of the Rheinfelden Power Works, the directors of which are represented by Mr. Rathenau (the general director of the Allgemeine Elektricitäts Gesellschaft), who is the founder of our enterprise, welcomes the gentlemen of the Institution of Electrical Engineers. It is a great pleasure to us that such a noble company of the electrical profession has honoured us with a visit in order to examine this great undertaking on which, during the past four years great sums of money, as well as energy and knowledge, have been spent; and since the work was completed it has already had a grand effect upon the industrial development of Rheinfelden and its surroundings, and also promises to remunerate those who undertook it. Of course, you, during your short visit, have only seen a small portion of our works and installations; you have also noticed that a great portion of the power generated by the turbines is utilised in our immediate neighbourhood in three great factories, but the other portion is transmitted by subterranean cables and overhead wires to transformers and substations, and thence to a great number of factories for motive power, and to several townships for lighting purposes. We sincerely hope that the slight insight you have had will enable you to form an idea of the entire undertaking. We also hope that on your journey through beautiful Switzerland you will be many times similarly impressed, and we dare to hope that as we shall always think with pleasure of the visit of the Institution of Electrical Engineers, so you will also keep the undertaking of the Power Transmission Works of Rheinfelden in remembrance.

I ask the gentlemen of the Power Transmission Works of Rheinfelden to lift their glasses and to drink with me the toast for the welfare of the Institution of Electrical Engineers of England!"

Prof. Thompson, in his reply, gave a brief *résumé* of Dr. Frey's speech in English, and proposed the toast of the Rheinfelden works.

The next speaker was Mr. Emil Rathenau:—

Ladies and gentlemen:—I think I am the only person here who really has no right to be here, because I am not a member of your honoured Society. . . . . I am sure you will see many things in Switzerland in the highest state of perfection, and you will go back to England having gained in knowledge; but what would you say if I invited you to Berlin? (Cheers)

Well, if you do come, I shall be very pleased to entertain you for two or three days, and I am sure, if I ask you, Messrs. Siemens and Halske will also invite you. (Applause.)

Mr. Rathenau suggested that the visit might be combined with an excursion to the Paris Exposition next year, and concluded by drinking the health of Dr. Thompson, the President, in which all joined heartily.

Mr. Crompton, rising to propose the health of Mr. Rathenau, said that, being one of the older men of the profession ("No, no!") he knew how Mr. Rathenau had fought for the electrical engineering industry, and how by his energy and perseverance he had brought the electrical industry of Switzerland and Germany to its present position in the world's commerce. Mr. Rathenau saw what enormous possibilities there were for the employment of capital, and had done for those countries what we wanted someone to do for England. If that had been done 10 years ago we should not now see so many orders go elsewhere, and we look to the Institution to produce a man like Mr. Rathenau. Mr. Crompton concluded by welcoming the suggestion of a visit to Berlin; and the health of Mr. Rathenau was drunk with cheers and choral honours, not a little to the astonishment of the orchestra, which was simply drowned. The curious little ascending runs with which the band accompanies and prolongs the German "Hoch" were by no means appreciated by the Englishmen, who found the unaccustomed addition to their cheers somewhat disconcerting.

Mr. Rathenau's son having replied on behalf of his father, toasted the adventurous ladies who had come so far to look at machinery; the gentleman who responded for them pointed out the beautiful mountains, beautiful rivers, and—beautiful electrical works!

Mr. Rathenau's generous offer will, we understand, be accepted for next year, but will not be combined with a visit to the Paris Exposition, as it is felt that the two events would constitute too large a programme; moreover, the Institution will, in any case, be represented at the Exposition by an official deputation to the Electrical Conference.

After lunch we adjourned to the railway station, and having taken leave of our hosts, proceeded to Baden, where Mr. C. E. L. Brown cordially greeted his old friends, and led the way to the works of Brown, Boveri & Co. There the party was split up, and each group was conducted through these works, splendidly equipped with modern machinery and full of alternators, motors, &c., chiefly of the three-phase type, in process of manufacture. Our own group suffered from a monopolist who wanted to discuss three-phase induction motors for traction with our guide, to the exclusion of all other men and things; this factor—an *induction factor*, so to speak—was the cause of our group dwindling away to two or three members, the rest, seeing no prospect of obtaining information from our leader as to the machinery, &c., having joined other groups. The chief objects of interest in the

works were probably the huge alternators, six of which were of 2,000 H.P. and upwards, and 25 were over 1,000 H.P.; most of these were of the inductor type, which seems to be very generally adopted in the Swiss works. A large switchboard for a carbide plant excited much interest, the switches being designed to break a load of no less than 2,000 KW. each, at 16,000 volts! It is very noteworthy that, in the case of all large switchboards, the working parts are placed behind the board, and operated from the front by means of levers; no part of the electrical circuits, or metal connected therewith, is placed on the front of the board.

After taking leave of Mr. Brown the party proceeded to Zurich, which was the headquarters for the greater part of the time; some annoyance was occasioned by the necessity of sharing rooms, owing to the heavy demand, and one load of luggage went astray, but these little difficulties were soon smoothed over, and the visitors passed the week-end in enjoying a rest, in excursions on the lake, or in walks to points of interest in the neighbourhood.

(*To be continued.*)

## ANIMAL ELECTRICITY.

By W. S. HEDLEY, M.D.

GALVANI'S experiment was this:—Laying the nerve muscle preparation on a glass plate, the nerve was raised with a glass rod, and then being allowed to touch the muscle, a contraction ensued. This was the demonstration of animal electricity, the existence of which Volta had denied. But Volta proved his assertion (which Galvani had denied) that metals in contact with a fluid produce an electric current. The demonstration of this latter fact was the discovery of the Voltaic cell.*

Animal and metal currents were first clearly differentiated by du Bois-Reymond. He considered, and it is difficult to prove the contrary, that a natural electric current exists in normal resting muscle, "current of rest." During the action of the muscle he proved the existence of a current in the opposite direction to the "rest current." This was called "the negative variation," now known as the "current of action." Hermann combats the opinion that a resting uninjured muscle shows any current, and holds that the so-called "current of rest" is the result of chemical or other inequalities due to the injury. The views of English physiologists are as follows:—

1. Normal muscle or nerve gives no current.
2. Local injury produces a current through the muscle from the injured to the living part.
3. Local action produces a current through the muscle from the active to the resting part.

Thus an injured or an active muscle produces electromotive force, and as in the Daniell cell the current goes from the active plate (the zinc) to the copper, so does current travel in the injured muscle from the injured part to the sound part. When the circuit is completed through a galvanometer, of course the direction is reversed, and it is usual to describe the direction of a current in its relation to the galvanometer. The manifestation of the sudden difference of potential which is the result of stimulation is sometimes spoken of as the "excitatory variation" when the muscle is referred to, and as the "action current" when the galvanometer is referred to.

*The Negative Variation.*—If a muscle giving the muscle current ("injury current") be tetanised, an action current will proceed from the uninjured to the injured part, *i.e.*, from the part more capable of action to the part less capable of action. This current being in a direction opposite to the muscle current (injury current) constitutes a counter electromotive force which tends to cut down or diminish the muscle current, and this diminution is the "negative variation" of du Bois-Reymond—"action current of Hermann."

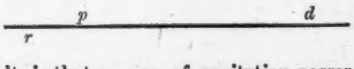
*The Diphasic Variation.*—A contraction wave propagated along the fibre of an uninjured muscle is accompanied by an electrical disturbance travelling from the active to the resting part, and this variation (as revealed by a galvanometer uniting two electrodes placed at an interval on the surface of a muscle) is double or diphasic for the obvious reason that the action is not simultaneous throughout the muscle, but requires time for its transmission.

By far the most striking manifestations of animal electricity are, of course, to be found in electric fishes; here the nerve surfaces represent the active element of the battery, viz., the zinc in the Daniell cell.

The electromotive action accompanying voluntary muscular contraction in the human subject has been demonstrated by du Bois-Reymond, and that accompanying tetanic contraction from electrical stimulation by Hermann. Physiologists consider that the variation of electrical potential from the beat of the human heart has been demonstrated. It is by some regarded as proved that the white columns of the spinal cord give electrical signs of nerve action, and even that action currents are manifested by the grey matter of nerve centres. The skin of all animals is traversed by an electrical current from without inwards. This is considered to be caused chiefly by cutaneous glands, but partly by the skin itself, as is proved in the case of the eel, whose skin has no glands. The action of light upon the retina causes an electrical change, *i.e.*, a current accompanies retinal activity, as it does muscle activity. Indeed, it is probable that electrical phenomena always accompany vital action.

Certain of the above points have been carefully studied by Sir J. Burdon-Sanderson, and his latest contribution to the subject comes in the form of the Croonian Lecture delivered before the Royal Society, for an abstract of which we are indebted to the pages of *Nature*. As might be expected from the direction of his previous investigations, it was the electrical rather than the chemical or mechanical concomitants of the function of muscular action that chiefly engaged his attention. But it was necessary to begin by explaining some points in connection with the mechanical effects. These could be investigated in two ways:—(1) By observing and recording the changes of form a muscle undergoes when, in response to a stimulus of short duration, it acts isotonically, as in lifting a weight; or (2) by observing the increase of tension which occurs in overcoming a resistance, *i.e.*, when it acts isometrically. The latter method is the best when dealing with an entire muscle, but isotonic conditions are preferable when estimating the time occupied by a *single* element of muscular structure in developing its maximum tension under stimulation.

The method employed consists in observing the change of surface form that occurs in a muscle when a single break induction current is led through it in such a way that the observed surface is at the cathode. A sensitised plate moves behind a slit, upon which a magnified image of the cathode (moving freely with the muscle) is thrown. An observation thus made shows that the process of contraction at the point immediately excited, *i.e.*, at the point immediately underneath the cathode, attains its greatest activity before the end of the first hundredth of a second. It is known, as already stated, that an electrical change, an action-current, accompanies the mechanical change, *i.e.*, the change of form which a contracting muscle undergoes. Are the change of form and the electrical variation synchronous, or does one precede the other? On connecting two parts of the surface of a muscle through a capillary electrometer or other galvanoscope, it is found (1) that similar parts in a similar physiological state are equi-potential; (2) that in similar parts, but in a different state, there is a difference of potential the less capable of function, *i.e.*, the less living being negative to the more living; (3) that transitory differences of potential arise between two parts of the living surface when the one is active and the other resting, the condition of rest or fitness for function being denoted by relative "positivity," discharge of function by relative "negativity." The "first fundamental experiment" was then described. A parallel fibred muscle (curarised) is submitted to an instantaneous stimulus at *r*.




The result is that a wave of excitation passes along each fibre, its progress being marked by electrical and mechanical change. The latter consists of an alteration of shape or

* For this and a portion of the following, see "Therapeutic Electricity," by W. S. Hedley, M.D. (Churchill, London.)

contour in the contracting muscle. If we have two contacts, *p* and *d*, applied to different parts of the contracting muscle and connected through a galvanometer, the electrical effect of the stimulation appears; it consists in the sudden manifestation of a difference of potential between the two parts of the contracting muscle.

Now, reverting to the mechanical effects (alteration of contour) produced by the stimulation, the photographed curve represents the wave of excitation as it starts from the point of stimulation, *r*, affecting first the near contact, *p*, and then the distant one, *d*. But if, by tying a tight ligature across the path of propagation we limit the observation to what happens at one contact only, "we find that the curve has assumed an entirely different form." It is natural to conjecture, and capable of proof, that the difference of contour in the two experiments represents the arrival of the wave of excitation at the distal electrode, *d*. A curve representing the change which occurs in the difference of potential between the surface of contact, *p*, and the rest of the surface of the muscle during excitation can be obtained by calculation from measurements of the polar ordinates of the curve resulting from the first experiment. Assuming an identical curve at *d*, but relating to a period 15,000ths of a second later, we may obtain the curve which expresses "what must be the successive differences of potential between *p* and *d*, when the effect of the change at *d* is not cancelled." If the curve be deduced from the second experiment, *i.e.*, where the change at *d is* cancelled, it coincides with that obtained by summation, where the change at *d* is not cancelled. Therefore, from *p*, we can obtain the curve which expresses the successive differences of potential required, and the determination of the monophasic variation ought to be the aim of such experiments.

The curves that represent the change of contour also represent the electrical response to excitation. The electrical state of the muscle when at *rest* depends upon the way in which the effect of the wave of excitation at the distal electrode is cancelled. If this be done by applying a ligature between *p* and *d*, the contacts remain equi-potential; if the part of the nerve to which *d* is applied be de-vitalised, *e.g.*, by heat, the unexcitable dead surface is found to be strongly "negative" to the other.

It thus becomes evident that the phenomena observed depend "exclusively upon the state of the surfaces of contact, and consequently when the distal contact is cancelled on that of the proximal contact only."

Having considered the electrical results of a single instantaneous excitation, further experiments were detailed, showing the electrical concomitants of continuous contraction. It has been contended that the continuity of voluntary muscular action is *apparent* only, and an identity in sound emitted by muscle contracting normally, and one contracting under a series of instantaneous stimuli, has been adduced in favour of this view. "It is argued that because we can produce continuous contraction (artificial tetanus) by discontinuous stimuli, that all continuous contraction is so produced." Putting such questions aside, and limiting attention to the electrical concomitants of continuous action, it was shown that under certain conditions a continuous contraction can be produced by a single uninterrupted stimulus, and that in reflex spasms there is no evidence of discontinuity, "at least, in the sense in which this term is ordinarily understood." There is rhythm, but it is central, not muscular. If spasm be artificially produced by exciting the motor apparatus through a sensory nerve, the cells of the cord having been rendered hyper-excitable by a dose of strychnia, a prolonged contraction occurs, the graphic tracing of which is often indistinguishable from that of complete tetanus. But by analysing the electrical concomitants as recorded photographically, it is seen that the curve resembles rather that of complete tetanus interrupted at regular intervals than that of a series of responses to single instantaneous stimuli following each other at $\frac{1}{10}$th of a second or more. Thus a single stimulus to the motor cells of the cord has produced a series of responses in the muscle, but, as already stated, the rhythm is central, *i.e.*, the motor cell has discharged its influence on the muscle at regular intervals, but the effect each time is that of continuous action.

A further interesting point in this connection was adverted to, and lies in the fact that by means of the alkaloid veratrine we can abrogate the mechanism by virtue of which a muscle, after responding to an instantaneous stimulus, returns to its previous state. In other words, under the influence of veratrine a muscle once thrown into action is compelled to continue that action, and the electrical phenomena under such circumstances show the effect to be absolutely continuous. The curve resembles that of artificial tetanus, showing no undulation or unevenness. Although the excitation is instantaneous, the response is continuous, and it is remarkable that a muscle so treated preserves its functional capacity unimpaired. In other words, a veratrinised muscle excited by an instantaneous stimulus will lift as great a weight, or do as much other work, as a normal muscle excited by a succession of instantaneous stimuli.

The contractions of the heart are analogous to those of the skeletal muscles, but, of course, the "relative negativity" spreads radially instead of longitudinally, the electrical effect appearing to precede the mechanical; but the duration of the process is longer, and the rate of propagation slower.

It was then explained that if the leaf of the Venus' fly-trap be explored in a similar way, changes occur analogous to those observed in the ventricle of the frog. But the interval of time between the culminations of the electrical response and that of the change of form is more obvious in the leaf than in the heart, for the reason, as the lecturer concluded by observing, that the mechanism by which the change of form shows itself works more slowly in the leaf than in the heart.

It does not seem quite clear how far the above experiments having reference to the time relationship between the electrical and the mechanical concomitants of contracting muscle bear upon certain other views on the same subject which certainly seem plausible. It is known that derangements in shape, produced mechanically, will show themselves electrically, *i.e.*, will produce the electric state, and conversely, that variations in the electric state are accompanied by derangements in shape. According to d'Arsonval given a surface that can be disturbed mechanically, as, for example, in all liquid and semi-liquid bodies, similar phenomena occur. Therefore it is sought to explain action currents by variations in surface tension, and consequently in the electric state, which is due to the "internal mechanical distortion that occurs in every living tissue which is undergoing change of shape." There is little doubt that the mechanical event, the change of form in a muscle, actually commences before it becomes apparent. It has been considered demonstrable that the electrical event actually accompanies the mechanical event. Could it be shown that the electrical disturbance is an event, actually as well as apparently, anterior in point of time to the actual change in shape, such an observation is clearly fatal to the last-named theory.

## THE ELECTROLYSIS OF HYDROCHLORIC ACID.

By D. TOMMASI.

The electrodes of the electrolyser being of platinum*, two cases may present themselves according to the degree of concentration of the hydrochloric acid. If the acid is concentrated, the anode is attacked by the chlorine and then acts as a soluble anode; if, on the other hand, the acid is diluted there is also a liberation of products of chlorine but the platinum is not attacked.

I will now discuss these different cases in succession. The electrolyser employed consisted of a U-shaped tube.

(a) *Hydrochloric acid highly concentrated* (D=1·2).—Two molecules of hydrochloric acid in a state of solution absorb, in decomposing, 78·6 cal.; but as the anode is attacked by the chlorine we must deduct from the 78·6 cal. the quantity of heat given off by the formation of the dissolved chloride of platinum, which tends to lower the electromotive force required to effect this electrolysis. In fact, the electrolysis of this acid can be effected with an electromotive force far below 1·7 volt (78·6 cal.) In this way a Daniell element (1·02 volt) and a zinc-cadmium element (·36 volt) decompose hydrochloric acid fairly rapidly, with liberation of hydrogen at the cathode, but without any production of gas at the anode.

A single Daniell element is sufficient, if necessary, to decompose hydrochloric acid, but the electrolysis is effected very slowly.

In order to get more certain results, I employed a Daniell element

* The platinum used was chemically pure.

and a zinc cadmium element, or a current with an electromotive force of 1·42 volt. After 20 hours the liberation of gas was still continuing at the cathode. The liquid of the electrolyser contained in solution a certain quantity of platinum.

I repeated this experiment, using an electromotive force somewhat higher than that indicated by theory as sufficient to decompose hydrochloric acid, two Daniell elements (2·04 volts). Under these conditions, the decomposition of hydrochloric acid is very rapid, but notwithstanding this, we see no liberation of gas effected at the anode; at the end of an hour, however, we see a few bubbles of gas forming on this electrode. After 20 hours the decomposition was still continuing with liberation of hydrogen at the cathode, and of products of chlorine at the anode.

The liquid of the electrolyser, when evaporated in a water-bath and then calcined in a current of hydrogen, left a residuum of perfectly pure platinum.

Still using two Daniell elements, the results obtained by electrolysing different mixtures of hydrochloric acid and water were the same as described above.

We observe a limit to this action with a mixture containing 10 per cent. of hydrochloric acid; and, in fact, the quantity dissolved is quite infinitesimal.

(*b*) *Dilute hydrochloric acid.*

| | | |
|---|---|---|
| Hydrochloric acid (D = 1·2) | ... | 5 cubic centimetres. |
| Distilled water ... ... | ... | 100 „ „ |

As soon as the circuit is closed, we see gas given off at the negative electrode only. After some time, the liquid in the positive branch of the U-shaped tube serving as electrolyser is slightly tinted yellow, and at once discolours litmus paper plunged into it.

The current was passed into it for 100 hours and then the liquid was subjected to analysis, which did not reveal the slightest trace of platinum.

On working with more and more diluted solutions of hydrochloric acid, the results obtained were always the same, which proves that, whatever may be the dilution of the acid, oxides of chlorine are constantly being given off accompanied perhaps by some traces of free chlorine arising from a secondary action.

But do these oxides of chlorine proceed from the decomposition of the hydrate $Cl_6H^{20}$ or from the oxygen of the water acting on the hydrochloric acid?

This it is impossible to find out, for these two reactions may be produced either separately or simultaneously.

In order to make sure that in the electrolysis of hydrochloric acid oxygenated compounds of chlorine really are produced, I precipitated the liquid of the electrolyser by a slight excess of nitrate of silver, I then filtered it and added zinc and sulphuric acid.

After some hours the liquid was filtered and nitrate of silver added to it which gave rise to the formation of a precipitate of chloride of silver. This reaction proves the presence of oxides of chlorine, and leads us to suspect amongst them the existence of hydrochloric acid.

I do not think, however, that in the electrolysis of concentrated hydrochloric acid hydrochlorous acid can be formed, for this as soon as produced would be decomposed, in the presence of hydrochloric acid, into water and chlorine.

## PROGRESS IN THE CALCIUM CARBIDE INDUSTRY.

By JOHN B. C. KERSHAW, F.I.C.

The manufacture of calcium carbide continues to attract more attention from capitalists and from company promoters than any other branch of the electro-metallurgical industry.

In the issue of the Electrical Review for January 13th, 1899, the writer gave a list of 32 places where works for the production of calcium carbide were in operation, and of 19 places where similar works were in course of erection.

Table I.—Calcium Carbide Works in Europe and America.

| Country. | No. in operation. | No. erecting. |
|---|---|---|
| France ... ... | 21 | 5 |
| Switzerland ... ... | 6 | 5 |
| United Kingdom ... | 3 | 1 |
| America ... ... | 5 | 4 |
| Germany ... ... | 4 | ... |
| Austria ... ... | 3 | 5 |
| Italy ... ... ... | 3 | 2 |
| Spain ... ... ... | 1 | 1 |
| Sweden ... ... | 1 | ... |
| Norway ... ... | ... | 2 |
| Russia... ... ... | ... | 1 |
| Totals ... ... | 47 | 26 |

Since that article was written, the carbide works at Ijace, Epierre, Chedde, Serres, and Giffre have been started, and works at the following additional places have been planned, and are now in course of erection:—Lourdes, in the Hte. Pyrenees; Niagara; Petrozsani, in Hungary; Hagneck, in Switzerland; Foligno, in Italy; Paternion, in Austria; St. Felix, in France; Bellegarde, in France; Sinnakoski Falls, in Finland; Gurtnellan and Amsteg, in Switzerland; Villelongue, in the Hte. Pyrenees; Chandiére, in Canada; and Arudy, in the Hte. Pyrenees.

In a paper read before the recent Acetylene Congress at Buda-Pesth, Guilbert, of Paris, gave details of the plant and machinery at each of the 21 carbide works now operating in France. These works are located in the two mountainous districts of the Hte. Savoy and the Hte. Pyrenees, and all utilise water-power. Several of these works were omitted from the present writer's previous estimate of the number of carbide works in operation.

The amended numbers are given in Table I.

From Guilbert's paper mentioned above, the figures in Table II, relating to the H.P. utilised and available for this manufacture in France have been taken:—

Table II.

Horse-Power Utilised in France for Carbide Production.

| Works. | Horse-power. Utilised. | Available. |
|---|---|---|
| Bellegarde ... ... | { 1. 1,200 2 500 | 8,000 ... |
| Chapareillon ... ... | 800 | ... |
| Chedde... ... ... | 2,000 | 12,000 |
| La Bathie ... ... | { 1. 1,250 2. 1,500 | 2,500 ... |
| N. D. de Briançon | 3,000 | ... |
| Epierre ... ... | 2,600 | ... |
| St. Béron ... ... | 2,000 | 4,000 |
| Sechilienne ... ... | 1,200 | 3,500 |
| Serres ... ... ... | 600 | ... |
| Giffre ... ... ... | 880 | ... |
| Froges... ... ... | 275 | ... |
| La Praz ... ... | ? | 15,000 |
| Albas ... ... ... | 1,450 | ... |
| Arudy ... ... ... | ... | 2,000 |
| Crampagna ... ... | 600 | ... |
| Castelet ... ... | ? | 2,500 |
| Marsaac ... ... | 350 | ... |
| Salies du Salat ... | 300 | 800 |
| Totals ... ... | 20,505 | 50,300 |

Outside France, the more important developments in connection with this manufacture are occurring at Ijace, in Hungary, where 8,000 H.P. is available, at Niagara, where the Union Carbide Works, of 10,000 H.P., is being erected, at Chandiere, in Canada, where 6,000 H.P. is to be utilised for carbide production, and at Sarpsborg in Norway.

The furnaces in use in the 47 works now in operation vary greatly in design and construction. According to one authority, a return is being made to simpler forms, many of the highly complicated structures which formed the basis of patents having, on trial, proved of little practical value.*

At Langenthal, in Switzerland, the furnaces are merely chambers of refractory fire-bricks, into which weigh-boxes of sheet-iron, containing the charges of lime and coke, are pushed.†

Borchers has patented a new furnace, which is designed to utilise the heat lost by radiation and conduction from the furnace walls. The furnace body is of sheet-iron, and is provided with a water jacket. The steam generated during the passage of the current and the cooling of the fused carbide is used for power generation ‡

At Bellegarde the Bertolus form of furnace is in use,§ while at St. Marcel, in Italy, the furnace patented by Memmo has been adopted.‖ It is interesting to note that at Langenthal, at St. Marcel, and at Bellegarde-sur-Valserine, triphase current is being used with success for carbide production.

With regard to the yield of carbide per H.H.P. there is little progress to report, and the actual yields obtained in some of the works now in operation are believed to be much below the maximum possible in well-conducted works.

At Méran, in Austria, an output of 5·2 kgs. per KW.-day is said to be obtained with the Gin and Leleux type of furnace, and according to M. Gin this equals a thermal efficiency of 92 per cent.¶

At St. Marcel, in Italy, with the Memmo furnace, an output of 4·88 kgs. per KW-day has been obtained.** Liebetanz, in his paper before the Buda-Pesth Congress, based his estimates on a yield of 5 kgs. per KW.-day of 24 hours,†† and this may be taken as the average for the best managed carbide factories.

The selling price of carbide still remains much higher than is justified by its cost of production. This is due chiefly to freight

* *L'Industrie Electrochimique*, December, 1898.
† "Excursion Electrotech. en Suisse," Chapter X.
‡ *Electrician*, May 19th, 1899.
§ *L'Industrie Electrochimique*, December, 1898.
‖ *L'Electricien*, July 8th, 1899.
¶ *L'Eclairage Electrique*, May 6th, 1899.
** *L'Electricien*, July 8th, 1899.
†† *Zeit. f. Angew. Chemie*, July 11th, 1899.

charges, which often add 50 per cent. to the price f.o.r. at the factory.

Thus at Lourdes, in the Hte. Pyrenees, where a carbide factory is now in course of erection, carbide from Switzerland and America is sold for £24 per ton, while it could be produced in the district for less than £12. In Switzerland carbide is selling for £14 per ton, while the same carbide in Paris costs £19 per ton. At Meran, in the Austrian Tyrol, it is estimated that the carbide costs only £7 5s. per ton f.o.r., after allowing for interest on capital and depreciation of plant. At Niagara it is estimated that the carbide now produced there costs between £7 5s. and £8 per ton, and it is hoped to reduce this cost to £6 by improvements in the furnaces and in the details of manufacture.

In a Consular report it has been stated that the wholesale price of carbide in France is £14 (packages extra), while the retail price is at the rate of £22 per ton. Stern, in an article on acetylene lighting in Germany,* states that the sale price of carbide in that country in small lots is at the rate of £17 10s. per ton. He considers this high price to be due to the action of speculators who have little regard for the advancement of the industry.

Liebetanz, in the paper alluded to above, estimates the cost of carbide, with steam-power, at £11 14s. per ton, and at £8 18s. when water-power is used. He points out that when the freight charges are excessive, it may be more economical to produce carbide in the district where it is consumed, by the aid of steam-power, than to import it from a distant factory operating by water-power. This is a truth which needs emphasising in these days, when almost every water-power in Europe is being developed for the manufacture of calcium carbide.

With regard to the financial position of the industry, carbide production does not in every case lead to large profits, and the warning given by the writer in earlier articles on this manufacture are in some cases being justified by events.

Thus the carbide works at St. Béron, in France, have been advertised for sale by auction—a proceeding hardly characteristic of a flourishing manufacture—and one of the few carbide works operating in England is stated to have shown a loss upon its first year's working accounts.

These facts show that the manufacture of calcium carbide is not one that may be lightly rushed into by capitalists ignorant of the conditions of supply and demand in this new industry, or of the position as regards furnace patent rights. Owing to non-acquaintance of promoters and others with the practical necessities of electric furnace work, as applied to carbide production, large sums have in many cases been paid for patents which, on further trial, have proved valueless; and in this manner many of the existing carbide companies have been over capitalised at the commencement of their career. As the price of carbide falls, such companies must inevitably go into liquidation, or write large sums off their capital account: and those companies which are using simpler forms of furnace, and have paid nothing for patent rights, will unquestionably be in the stronger position.

## THE ELECTRIC LIGHTING OF LYNN.

We are now able to follow up our description of the electric lighting installation at King's Lynn with a few notes and drawings of the reversing joint boxes, fuse boxes, disconnecting boxes, &c., supplied by Messrs. Siemens Bros. & Co.

Fig. 1 shows a house junction fuse box, which consists of a cast-iron box in two halves, which bolt together; the lower part is filled with compound after the house service leads have been connected. In the top part of the box is a porcelain dish, which contains the fuses. The leads from the mains are brought through ebonite bushes, which are placed in the bottom of the top part of box to the fuse holders. The top covering for this box is glass, so fitted as to keep out water. Each of the boxes is fixed in a brick pit and provided with a cast-iron frame and cover, so that it is accessible at all times.

Fig. 2 is a public lamp service box which is made somewhat similar to the house fuse box, but instead of having a porcelain dish, it has glass tubes to cover the fuse between the service cable to lamp and main. These also are provided with a cast-iron frame and cover.

In fig. 3 are shown sectional views of a fuse box on triple concentric distributing mains. It consists of three parts. The centre part is provided with holes into which are screwed ebonite brushes, and through these the G M. connections from the mains pass which carry the links or fuses. After the connections are made the box is bolted together and the lower part filled with insulating compound. There is a cover of sheet glass, and over this an additional cover made of tin plate, with handle for lifting on and off for inspection of fuses, &c. These also are placed in brick pits with frame and cover.

Fig. 4 shows the type of reversing joint made on the mains, and consists of a cast-iron box in halves, bolted together and filled with compound. In the box the cables lie side by side, but with a space between them, and where the conductors have to be connected the insulation is cut away; a distance piece made of gun-metal is inserted, and the whole bound with copper wire and soldered.

In connecting either of the two outer conductors, a thin tinned copper ring is slipped under the wires to protect the inner insulation from injury by the tinning of the conductors.

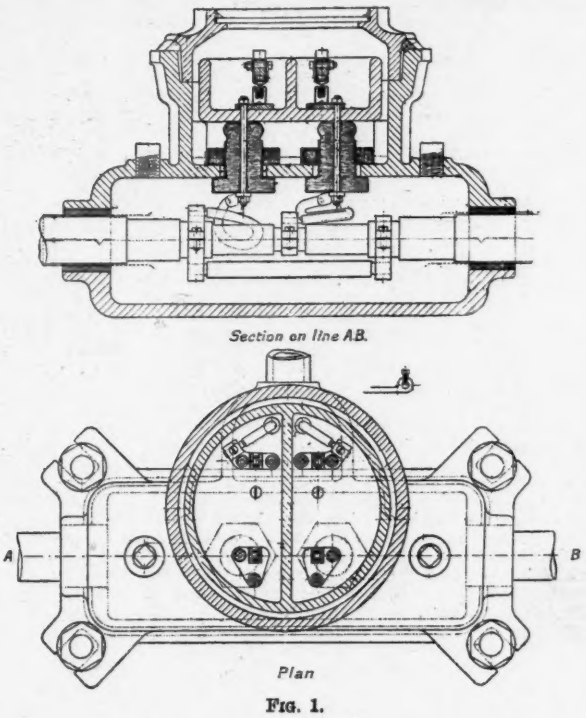
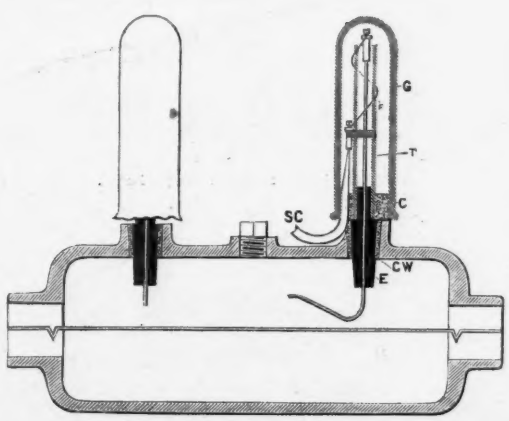



Fig. 1.

After being soldered the whole is taped over before running in the insulating compound.

Twenty-three boxes were supplied for joints between new and existing mains They consist of cast-iron boxes in two pieces, which are bolted together and filled with insulating compound. The method of jointing is the same as that employed in making the joints shown in fig. 4.




G, Glass case; T, Glass or porcelain tube; F, Fuse wire; C, Cork; S C, Service cable to lamp; E, Ebonite; C W, Cork washer.

Fig. 2.

The Davy arc lamps are of the enclosed type, arranged to burn two in series on a 200-volt circuit. The outside of the lamp consists of an ornamental metal spinning and an opal globe.

The Siemens arc lamps are of the well-known "band" type, constructed to burn four in series on a 200-volt circuit. They are fitted

E

* *Journal fur Gasbeleuchtung*, 1899, p. 262.

with globes and lanterns, modified so as to suit special canopies supplied with the posts made by Messrs. Law.

The two-light and one-light ornamental incandescent fittings are of the patterns shown by figs. 5 and 6, and consist of a clear well glass enamelled reflector and ornamental cover. The reflector is made in two pieces: one piece is perforated for the insertion of lamp or lamps, and fixed to the cover of the fitting; the other part is hinged at one side, and fastened by means of a catch to the cover, which is further secured by means of a small set screw. The holders are attached to a small watertight box, which can be opened to facilitate

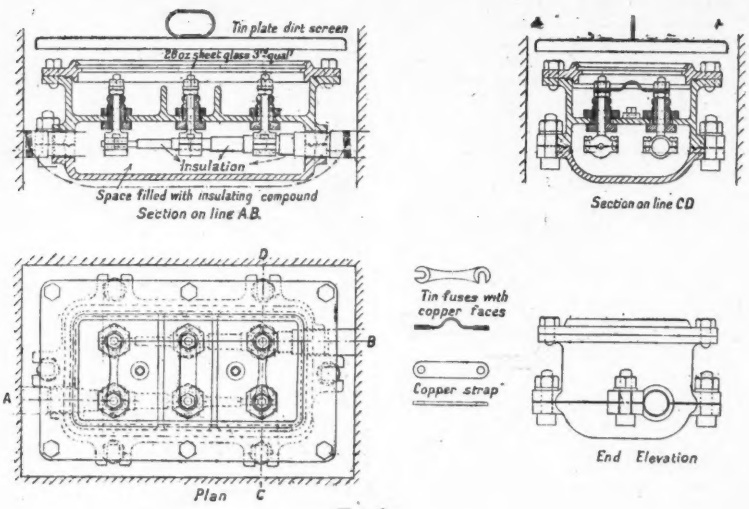
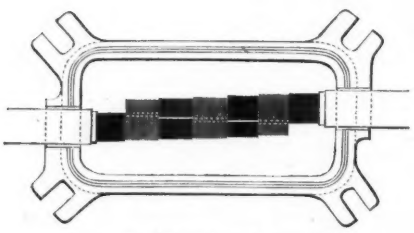


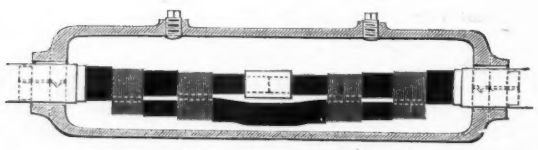

Fig. 3.

wiring in the manner shown by the drawings. It will be observed that the lips of the well glasses are held tightly between rubber gaskets, which help to keep the inside of fittings watertight.

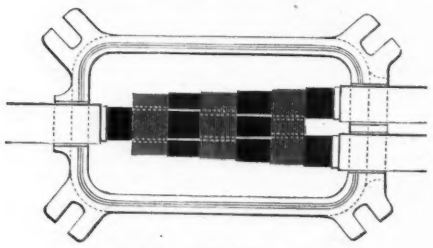
The ornamental finial shown in fig. 6 is only used in the case of the fittings being hung from suspension wires carried across some of the streets, as illustrated last week.



Two-way joint box (reversing polarity).



Two-way joint box (not reversing polarity).



Three-way joint box.

Fig. 4.

The single-light incandescent fittings for arc lamp-posts consist of clear well glass fixed in a hinged frame, attached and locked to the cover of fitting much in the same way as in the case of the ornamental fittings. The inside of the cover is enamelled.

## THE ENGINE BOILER AND EMPLOYERS' LIABILITY INSURANCE COMPANY.

The annual report of this company, recently published, contains a few items of some interest, namely, an economy trial of a steam engine showing very low steam consumption and an evaporative test with a water-tube boiler as a reply to numerous enquiries in regard to water-tube boiler performance. The engine test was made on a

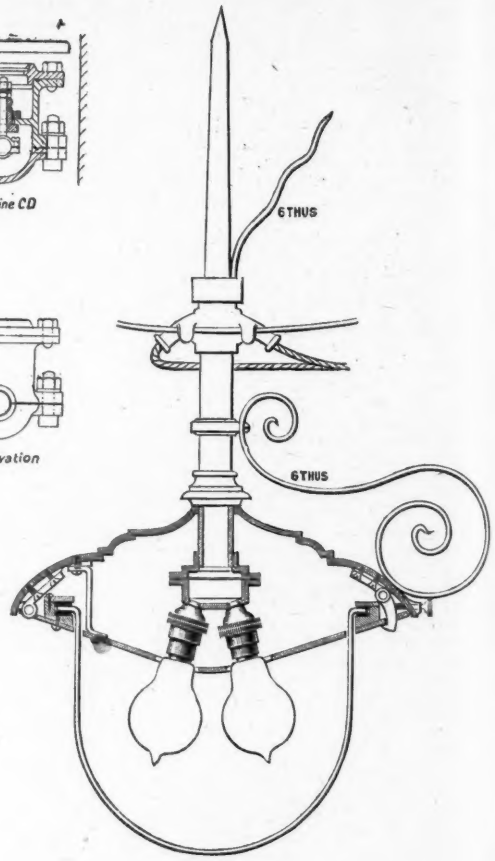



Fig. 5.

compound engine of Messrs. Cole, Marchent & Morley's make. It had cylinder jackets everywhere except to the front of the L.P. cylinder, and Corliss valves throughout. The H.P. cylinder had a thoroughfare jacket, and there was an intermediate heater receiver

Fig. 6.

with a boiler pressure copper coil. The condenser had 1,500 feet of tube surface, but it was dirty and showed 31° difference of temperature between hot well and discharge. The cylinders were $19\frac{1}{16}$ and $36\frac{1}{16}$" diameter, the stroke 4 feet 6. The H.P. piston rod was

4 inches, and the front L.P. rod was 5 inches diameter. Clearance volume of both ends was 0·462 and 1·8 cubic feet respectively, the clearance surfaces of both ends 11·24 and 31·28 square feet respectively. The revolutions were 73·16 and 73 35, on two trials, the gauge pressure in boiler 105 and 107 lbs. corresponding to 341° and 342° of temperature. The I.H.P. was 508·4 and 497 1, the steam consumption being 14·14 and 14·27 lbs. per I.H.P.-hour, an excellent result at the pressure. Of 214,500 units of work theoretically possible to obtain between the temperature of the boiler and the air pump discharge, 140,000 were actually secured as I.H.P., or ·653, the mean effective pressure being 25·35 referred to the larger cylinder. The range of temperature was 102° in each cylinder, and the H.P. per square inch of L.P. cylinder 20·06. Of the actual heat received by the engines, namely, 279·2 units per minute per I.H.P., 42 7 were utilised. Calculations of the clearance surfaces exposed to initial steam have been made and show 15 7 and 41·5 square feet per pound of steam, while the total initial admission surface, *i.e.*, the surface at cut-off, was 25·5 and 62 8 square feet per lb. of steam respectively in the two cylinders, the steam present as steam at the end of admission being 89·4 and 78·6 in the two cylinders respectively, showing 10 6 and 21·4 per cent. of water, while at release the water present was 6·1 and 13 9. An unjacketed cylinder of much the same proportions of clearance surface showed, in 1896, percentages of water at the end of admission 14 and 29 per cent. The difference is ascribed to the beneficial action of the jackets. It is a pity we do not get more data of engine tests, including clearance surfaces. There is nothing about a steam engine which exercises such a serious influence on economy as the internal clearance surface, and no man has done more to point this out than Mr. M. Longridge of the above company. With 25½ feet of surface exposed to each pound of steam, it is obvious that as 10 6 per cent. of the steam was condensed in the H.P. cylinder, this surface must have absorbed 93 heat units, or 3 6 units per square foot, in becoming heated from the terminal to the initial temperature, or say, 102°. To heat up a square foot of cast-iron of 1 inch thickness 102° requires approximately 468 units. As only 3·6 are available, it follows that the mean heated thickness of metal or skin is $\frac{1}{130}$th of an inch, which corresponds closely with the customarily assumed $\frac{1}{100}$th, the difference being jacket benefit. As 93 heat units are still lacking, any further improvement must come from superheat. 100° of superheat would yield about 37 units, which with the well-known cumulative action would probably abolish or nearly abolish the remaining 10 per cent. of liquefaction.

The water-tube boiler which was tested was of the small tube type with tubes vertical or highly pitched and known as the Glasgow boiler. From ·415 to ·563 lb. of coal was burned per foot of heating surface. The coal had a calorific value of 12,012 B.T.U.

Of this 68 per cent. was transferred to the water, 26 per cent. to the chimney, and 6 per cent. was lost as radiation, &c. The heating surface was 4,230 feet for a grate area of 66 feet, the ratio being the high one of 1 : 64, and it is remarked that if 40 per cent. of the surface were put into a feed heater and taken from the boiler the results might have been better, for the gases left the boiler in every test at over 600°, in one at 673°. From 26·6 to 36 lbs. of coal were used per square foot of grate per hour and the "from and at 212°" equivalent evaporation per pound of combustible was 9·22 to 9 63 lbs. The duration of the tests was about 8 hours, the fires being judged as to condition at beginning and end of the tests. This is a method by no means easy to carry out, and where the firing and duty is regular we are much inclined to think that a little used system would prove better. We refer to the system of getting well under weigh and starting the test when the steam pressure commences to drop after the last previous firing, finishing the test in the same way at the instant steam commences to drop in pressure after the last previous firing about the pre-determined hour for stopping. We think in this way that the state of the fire would be more accurately balanced at each end of a run than it can be by estimation.

A further note in the report is on the resistance to the flow of water through surface condensers. With 679 tubes of 6 feet 2 inches length and ⅝ inch external diameter placed in two series, having areas of passage ·814 and ·75 square foot respectively, with inlet and discharge pipes of ·196 square foot area each, a 6-inch centrifugal pump at 820 revolutions per minute caused a difference of pressure of 1·82 and 3·05 feet of water in two tests where 1·21 and 1·72 cubic feet of water per second was flowing. In gallons per hour these figures are about 27,000 and 38,000.

These figures should be useful now that surface condensing is becoming so common. Will not Mr. Longridge now give us some results of steam consumption by direct-acting steam air-pumps? We fancy it might be just as well to work high pressure as to use condensers with these direct-acting pumps.

## RECENT EXPERIMENTS WITH STEAM ON COMMON ROADS.

Those interested in this subject should obtain the full text of Mr. Thorneycroft's paper read on Tuesday at the meeting of the British Association at Dover. Mr. Thorneycroft has given great attention to these vehicles, and has built many. He tells us that one Ramsay invented a steam wagon nearly 300 years ago, and that Newton himself gave the subject his attention, though how the steam was applied is not stated. Progress is still hampered by the Locomotive Act of 1896, which, though more liberal than its predecessor, is still far from perfect, and its great drawback is the limit it imposes in respect of weight. Three tons is not sufficient for a commercially possible vehicle to carry the 5 and 10 tons insisted on by merchants to form paying loads.

Greater latitude is allowed in France, where a 4-ton vehicle is found necessary to carry 1½ tons of persons. In Lancashire loads of 10 tons are carried on four wheels at 2 miles per hour, the tyre load being 2·3 tons per inch of width. A steam wagon is recommended of 16½ tons to carry a load of 10 tons on four tyres of 25 inches total breadth. We do not see why there need be much desire to reduce tyre widths. Additional breadth does not add much to the weight, but it does help to preserve the road surface, and to reduce traction. Curiously enough, the widest wheels are found where the roads are best. The County of Lincoln, for example, with so many soft roads, is noted for its narrow tyred carts.

Mr. Thorneycroft doubts whether even the pure feed water is sufficient to counterbalance the air condenser, which sometimes gives very greasy feeds. An air condenser must have gills on its thin copper pipes or it will not act, and it must have a fan to keep it cool, and the fan absorbs about 12 per cent. of the total engine power.

A van supplied to Chiswick Vestry has 65 feet of heating surface in its boiler, 2½ feet of grate area, carries 175 lbs. pressure, has cylinders 3 inches and 5 inches by 3 inches stroke, with cranks at 180°, and cylinders on opposite sides of the shaft for balance. To prevent rust when standing idle the frames, guides, valves, pistons, and rods are of bronze. Renold chain gears are used, and the air condenser has 145 square feet of surface. Steel disc wheels have proved heavy, and the satisfactory wheel is a felloe driven wheel with metal naves, oak spokes and ash felloes, with thick and wide tyres driven on hydraulically. Superheating is of doubtful value, because of the apparatus being unsuitable for such service. Exhaust feed heating is valuable. For ordinary purposes no variable gear is necessary with steam power, which is sufficiently elastic to meet all ordinary wants. A special gear, however, is applied by Mr. Thorneycroft for soft roads and steep hills.

Welsh coal is recommended for fuel, and very much depends on the driver, who should be competent to deal with any small defects that may be met with on the road. Finally, the author believes that the problem of the light locomotive is already solved, but we might add that it has been solved by making the light locomotive heavy, or, at least, by demanding that it should be heavy. We certainly agree with this. For freight traffic we think the roads of this country will meet their best use in a slow and heavy traffic for freight, rather than in a light and fast traffic. But we also believe that the light railway has not been exploited to its full extent. The Light Railways Act was intended to provide for the construction of light railways, but it has been made almost a dead letter as regards electrical working by the foolish and obstructive tactics of the local authorities. We venture to say that the Light Railways Act never intended local authorities to use their powers or rights under the Act purely for the purpose of obstruction.

## CORRESPONDENCE.

### Stresses in Engine Shafts.

I am somewhat at a loss to catch Mr. Taylor's drift. Let me try to make things more definite. I will say nothing of how much the current may exceed the normal, be it 100, or be it 200 per cent. Instead, I will ask Mr. Taylor to state a maximum figure for the current passing at any moment. Then let it be assumed that this maximum current is suddenly applied from a condition of no current. Assume that a current of 200 amperes is thus suddenly applied upon a previously unloaded set. Then I maintain that the shaft stress set up by this current cannot exceed double that due to a gradually applied load of the same amount. A suddenly-applied load cannot induce greater stresses than are applied by a steady load of double the amount.

Mr. Taylor will please note that I have not fixed any figure as representing what may not be exceeded as between normal and maximum current. What I do claim is that, given a maximum beyond which the current will not rise, the actual stress cannot exceed that due to a steady current of, at most, double that maximum. Now there is the time lag of the machine, and whatever this may be, its effect can only be to reduce the suddenness of application of the stress.

Further, to take Mr. Taylor's figures for the Waterloo and City line, it appears that the circuit breakers are adjusted for a load of 2 8 times the normal. If this figure were given me as maximum, I would calculate torsional stresses to suit a steady load of 5·6 times normal. If, as Mr. Taylor says, there is a rise of current beyond the 2 8, then whatever this is I would provide for double. Obviously, what is now wanted is that we should know what is the time of movement of the circuit breaker. Mr. Taylor evidently believes

that the lag of the circuit breaker is more than the lag of the generator. The desideratum is a circuit breaker more rapid than the rate of current increase of the generator. Now, no one has suggested that the output is not liable to severe fluctuation. But I am unaware of any tests to determine the information asked for by Mr. Taylor as to the rate of increase of current when short circuited at an E.M.F. of 500 volts or any other figure. Clearly, we are both seeking the same information.

Granting that current may increase beyond that at which the circuit breaker is *set*, does not this point to the need of a comparatively light setting of the breakers? I see no risk by frequent opening of these. There is much risk by overloading them. It is certainly not convenient that the breakers should too frequently act, but if they went off a little oftener, they would afford something for attendants to do in putting them in again. Finally, however, I would point out that the dimensions of a shaft necessary for bearing pressures of sufficiently small intensity per square inch, and of a stiffness sufficient to carry fly-wheel loads, are such as to afford a very large margin of torsional strength.

If a 3-inch shaft, at 90 revolutions, will turn a steady load of 40 H.P., as per same tables, then, for a steady 4,000 H.P., a shaft of 13·8 inches would be needed. But this would neither suffice to carry the fly-wheel nor to provide bearing surface. The true power to provide for, however, would appear to be $4{,}000 \times 2{\cdot}8 \times 2$, or 22,400. Call it 24,000 to allow for an internal bore, and the diameter comes out at 25·3 inches, and this corresponds with general ideas as to size, with other reasonable dimensions. Thus a very great excess of load suddenly applied is still provided in the dimensions demanded by considerations quite outside the question of twisting moments. The lesson certainly appears to be that unless circuit breakers can be made to set an absolute limit to output, the design of a generator and fly-wheel should be such, as pointed out in my second article (ELECTRICAL REVIEW, September 15th), as will prevent stresses passing through the shaft between the fly-rim and the armature.

The Writer of the Article.

P.S.—Since writing the above, I note that a writer in the *Engineer* has advanced the same idea as myself in regard to the action of a fly-wheel in protecting an engine. Is it not a very obvious error in so many American engines that the crank is placed between the fly-wheel and the generator? This ought never to be done.

### Pulverisation of Metal Cathodes.

I have read in the ELECTRICAL REVIEW, dated August 4th, a Note entitled "The Pulverisation of Metal Cathodes," in which mention is made of the electrolysis of hydrochloric acid with platinum electrodes. With regard to this subject, allow me to remind you that in 1882 I made a minute and careful study of the electrolysis of hydrochloric acid under various degrees of concentration, using as electrodes sheets of platinum. I send you herewith a copy of the note I presented to the Academy in 1882, and if, as I hope, you find that this note may prove of interest to your readers, you will oblige me very much by publishing it in your estimable journal.*

D. Tommasi.

**The Hogging of Welded Tram Rails.**—Rails which have been welded up at night are liable to twist if the road material is removed during the daytime if the sun is at all strong. They may be straightened up temporarily by playing cold water on them, but there will always be some uncertainty as to what will happen when welded rails are uncovered for tamping or other purposes in years to come. The last word has not been said about rail bonds, and it may turn out that after all the plastic amalgam bond is the best all-round method from both the financial and practical points of view. The vibration and slight endway movement which is always going on, tends of itself to keep the amalgam joint in good order.

* Dr. Tommasi's article appears in another column.—EDS. ELEC. REV.

## BUSINESS NOTICES, &c.

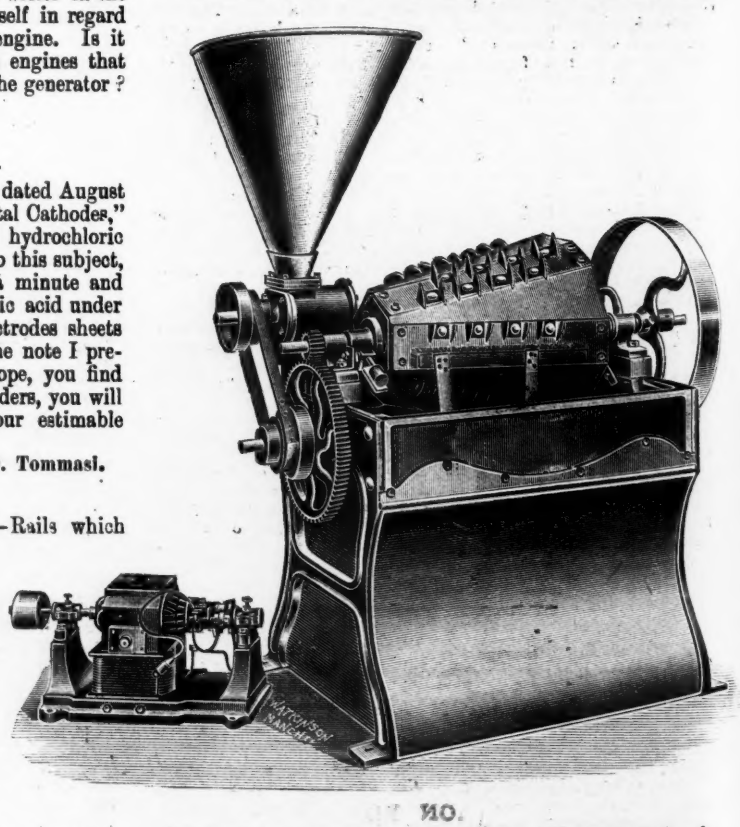
### Electrical Wares Exported.

| WEEK ENDING SEPT 20TH, 1898 | | WEEK ENDING SEPT 19TH, 1899 | |
|---|---|---|---|
| Adelaide | Value £1,150 | Amsterdam. | Value £20 |
| Alexandria | 20 | Bombay | 298 |
| Auckland | 49 | Boulogne | 97 |
| Bangkok | 256 | Buenos Ayres | 103 |
| Boulogne | 20 | " Teleg. mat. | 80 |
| Brisbane | 160 | Calcutta | 868 |
| Buenos Ayres | 697 | Canterbury | 155 |
| " Teleg. mat. | 100 | Cape Town | 46 |
| Calcutta | 26 | Channel Islands | 830 |
| Cape Town | 376 | Chinde. Teleg. gear | 11 |
| Chinde | 1,060 | Christiania | 27 |
| Colombo | 102 | Colombo | 162 |
| Constantinople | 45 | Durban | 366 |
| Copenhagen | 95 | East London | 113 |
| Delagoa Bay | 300 | Falkland Islands | 10 |
| Demerara. Teleg. mat. | 82 | Flushing | 11 |
| East London | 1,033 | Hamburg. Teleg. mat. | 810 |
| Flushing | 24 | Korsor. Teleg. cable. | 9,900 |
| Gothenburg | 79 | Lisbon | 65 |
| Hamburg | 400 | Montreal | 60 |
| Hong Kong | 148 | Ostend | 230 |
| Melbourne | 267 | Perth | 40 |
| " Teleg. mat. | 54 | Port Elizabeth. Teleg. mat. | 83 |
| " Teleph. mat. | 146 | Rio Janeiro | 212 |
| Paris | 9 | " Teleg. mat. | 87 |
| Rotterdam | 12 | Rotterdam | 85 |
| St. Petersburg | 90 | " Teleg. wire | 27 |
| " Teleg mat. | 71 | Santos | 54 |
| Singapore | 94 | Santiago | 185 |
| " Teleg. mat. | 954 | Shanghai | 65 |
| Stockholm. Teleg. mat. | 215 | " Old teleg. wire | 157 |
| Sydney | 66 | Singapore | 17 |
| Tientsin. Teleg. mat. | 110 | Sydney | 1,114 |
| Yokohama. Elec. teleg. cable | 14,315 | Trieste. Teleg. mat. | 600 |
| | | Yokohama | 619 |
| Total | £22,645 | Total | £15,598 |

### Foreign Goods Transhipped.

| | |
|---|---|
| New York. Elec. carriages. | Value £250 |
| Singapore. Elec. light mat. | 8 |
| Total | £258 |

**Electro-magnetic Separator.**—We illustrate below a patent electro-magnetic separator for which Mr. J. F. Butterworth, of 28, Queen Street, E.C., is the agent over here. The special features of this machine, which distinguish it from others, are:—(1) The use of electro-magnets instead of permanent magnets. This enables the magnetism to be controlled as described below. It secures a constant magnetic force, whereas the so-called permanent magnet gradually



NO.

loses strength and becomes useless. (2) The patent automatic knock-off motion whereby the magnets are demagnetised for a small portion of each revolution, allowing the iron collected to drop into the receiver and leave the magnets free for new collection; this is claimed to be a great advantage over the permanent magnets, which are

most difficult to clear. These advantages enable the electro-magnetic separator to maintain a very high output without skilled labour or attention. A machine with an output of two tons per day runs at a speed of 30 revolutions (7 volts, 21 amperes); the dynamo for driving same runs at 1,800 revolutions, and the power required to drive the dynamo and separator is 1 H.P. actual. The separator is in use at the works of a number of English engineering firms.

**Accumulators in Germany.**—Die Oberspree Gesellschaft für Accumulatorenwerke is the title of a company which has just been formed in Berlin with a capital of £150,000, to acquire and exploit the accumulator patents of Dr. Majert.

**Auction Sale.**—From our advertisements may be obtained particulars of the stock and plant of an electrical manufacturer and agent, which is to be sold by auction by Messrs. Percy Huddleston and Co., at 120 Minories, E., on Wednesday next, 27th inst.

**Bankruptcy Proceedings.**—In the failure of Mr. S. F. Walker, electrical engineer, Cardiff, Mr. C. E. Dovey, of 31, Queen Street, Cardiff, has been appointed trustee.

Before Mr. E. L. Hough, official receiver, on the 19th inst., in the Bankruptcy Court, a first meeting of creditors was held in *re* J. Stewart Edwards. The debtor, described as an electrical engineer, of Moorgate Court, E.C., states that his business was that of a general commission merchant, which he commenced in June, 1895, with no capital. He estimates his liabilities at about £13,000, the value of his assets not yet being ascertained. Since 1895 he has lost about £1,000 by speculations on the Stock Exchange. It further appears that the debtor has been engaged in ventures which have proved unsuccessful; that he has forfeited about £5,000 or £6,000 in respect of options, and that he has incurred a loss by contributing to the expenses of promoting an abortive company. It was stated that the debtor was desirous of submitting a proposal, and an adjournment was accordingly granted.

**Dissolutions.** — Messrs. P. Speedy, C. H. Congdon, and G. L. Eynon (Speedy, Congdon & Co., electrical engineers and contractors, 14, Victoria Street, S.W.), have dissolved partnership. Messrs. Speedy & Eynon will continue the business as Speedy, Eynon & Co.

Messrs. C. F. Hengst and F. S. Thomas (Saxonia Electrical Wire Company, engineers and electricians, Burwash Road, Plumstead) have dissolved partnership. Debts, &c., will be attended to by F. S. Thomas.

**Book Received.**—"Gas and Electric Lighting Works Directory and Statistics, 1899." 6s. net. London: Hasell, Watson and Viney, Limited.

**Catalogues.**—Messrs. B. R. Rowland & Co., of Manchester, send us a descriptive pamphlet of the Morrin "Climax" water-tube safety boiler, which they manufacture; the boiler is of the vertical type, very compact, and has been extensively adopted in the United States.

Messrs. John Spencer, Limited, of Wednesbury, sends us a revised price list of gas, steam, and water tubes and fittings.

**Deed of Assignment.**—Messrs. Woodburn & Holme, solicitors, of Liverpool, inform us that Mr. F. G. Robinson, of 9, Shand Street, Liverpool, electrical engineer, trading as the Shand Electric Company, on 12th inst., executed a deed of assignment of his property for the benefit of his creditors. The trustee is Mr. Wm. F. Levy (accountant), of Central Buildings, 41, North John Street, Liverpool.

**Educational Notices.**—The next session of the Battersea Polytechnic, S.W., evening electrical and general engineering classes, commences on September 25th. The evening class session at the Northampton Institute, Clerkenwell, also opens on 25th inst. See our Advertisement Pages.

We have received the prospectus of day and evening classes at the South Western Polytechnic, Manresa Road, Chelsea, for the 1899-1900 session. There are a number of classes in electrical engineering *re* which separate pamphlets are issued. These prospectuses are as usual got up in very interesting style with a number of illustrations showing the various departments.

**Electrical Engineering Company for Alloa.**—According to the *Edinburgh Evening News*, it is proposed to establish an electrical engineering company in Alloa, where all kinds of plant and appliances used in connection with electrical undertakings can be produced. A convenient site has been offered near the banks of the river Forth, and it is understood that the selection of the site now lies between Alloa and a rival claim by Coatbridge.

**Extension to Johnson & Phillips's Cable Works.**—Owing to rapidly increasing business Messrs. Johnson & Phillips have just broken ground for a large extension to their cable works. The department has been for some time under the immediate supervision of Mr. S. Paterson, ably seconded by Mr. P. W. Sankey, the works superintendent. The firm hope to get their share of the many underground cable contracts which are now being placed, and, as in the past, they will make special efforts to cope with Colonial and foreign trade.

**Intended Dividends.**—Notices appear in the *London Gazette* of intended dividends in the cases of W. A. Charles and J. S. Blackwell (Central Electrical and Engineering Company, Leicester), and of F. Marson (F. Marson & Co., Leicester, electricians and ironmongers); also in the case of Thomas Ford (T. Ford & Co., chandelier and electric fittings manufacturer, Birmingham).

**Name Plates.**—Mr. Paul Goldschmidt, of Featherstone Buildings, Holborn, sends us specimens of some new patent and very neat metal name and address plates which are made on a new improved chemical process by firing and silver enamelling, not by printing. They are claimed to resist all effects of climate, to keep always the original colour, and further, they may be bent without damage to the lettering. They are said to have been well received by leading engineering firms and to be cheaper than ivory plates.

**Trade Announcements.**—Messrs. Krupka & Jacoby ask us to state that they are still continuing their business at Watling Street, the winding up of the Phaeton Electrical Company in no way affecting them.

Messrs. Julius Sax & Co., Limited, inform us, with reference to a note under the above heading in our last issue, that the company has gone into liquidation merely as a formal matter with the object of reconstruction, and for the purpose of introducing new working capital into the business, which will be carried on as before.

## ELECTRIC LIGHTING NOTES.

**Ayr.**—The accounts for the past year show that the electricity works are now beginning to become profitable. The supply pressure is about to be raised to 200 volts, to relieve the overloading of the mains in the centre of the town.

**Bangor.**—At Bangor steady progress is being made with the installation of the electric light. A contract for laying cables has been let to the British Insulated Wire Company, who have already laid mains along Garth Road and Farrar Road.

**Barnsley.**—A Committee of the Board of Guardians has recommended that the workhouse be electrically lighted at a cost of £924.

**Birmingham.**—The electric lighting and power plant for the new works of the Birmingham Railway Carriage and Wagon Company, Limited, has been given to Messrs. Ellis & Ward, of Birmingham, the present requirements consisting of several hundreds of incandescent lamps and some 50 arc lamps. The generators will be driven by steam power, which is also being supplied by the above firm.

**Brighton.**—Mr. Wright has presented a report to the Lighting Committee, in which he states that even if the present works were extended to cover the whole of the available space, they would be inadequate to meet the demand for more than five years, having regard to the rapid rate of increase of business. He recommends that a site be acquired outside the borough capable of housing generating plant of at least 50,000 H.P., and that a station of 25,000 H.P. capacity be erected thereon. The reduction in carriage of coal and the facilities for condensation will result in an annual saving of over £10,000, allowing for the interest on cost of mains from the site at Aldrington, which he prefers. The pressure to be adopted is 10,000 volts. The Lighting Committee approved of the report, and was to lay the project before the Council yesterday.

**Broughty Ferry.**—The Burgh Commissioners have received the report of Mr. Fedden on the subject of electric lighting, and have decided to take immediate steps towards obtaining a provisional order.

**Cheadle.**—The Council has appointed an Electric Lighting Committee with a view to applying for an electric lighting order.

**Cheltenham.**—An inquiry was held last week by Colonel Hepper, R.E., inspector under the Local Government Board, into an application made by the Corporation for sanction to the borrowing of £16,600 for extension of works, plant, and mains, &c., in connection with the electric light undertaking. The Mayor, as chairman of the Lighting Committee, stated that last year the receipts of the undertaking were £2,148 over and above the working expenses. The current now supplied to private consumers was equal to 20,885 8-C.P. lamps. For street lighting, there were at present 197 arc lamps in use, and 100 more were ordered. The average cost of the current to private consumers (reckoning discount and rebate) was 5d. per unit. Mr. Kilgour, borough electrical engineer, gave details of the new plant, &c., required. There was no opposition to the application.

**Coatbridge.**—At the last meeting of the Town Council the accounts of the local branch of the Scottish House-to-House Electricity Company, Limited, for the year were submitted. The following is the revenue account:—The expenditure for the year amounted to £1,570 0s. 4d., as compared with £1,319 11s. in the preceding year, and the revenue received is £877 14s. 6d., as against £905 2s. for the preceding year. The loss on the year's working amounts to £692 5s. 10d., which, with the interest paid on mortgages and bonds of £997 14s. 1d., in all £1,689 19s. 11d., as compared with £1,294 7s. 5d. of the previous year. The total losses, &c., at the debit of suspense account, as at December 31st, 1898, amount to £8,076 8s. Electricity generated:—The total quantity generated in Board of Trade units is 61,864, as compared with 64,834 of the previous year, and the quantity unaccounted for is 22,053.

**Derry.**—The Lighting Committee has received a letter from the British Thomson-Houston Company, Limited, in which the charges (6d. and 2d.) recommended by Mr. Christie in his report are criticised as being too low. Mr. Christie has also sent in a second report, and the Corporation has decided to consult Sir W. H. Preece as well. Have we here a multitude of counsellors, or too many cooks?

**Dublin.**—After providing for working expenses, repayment of principal and interest on loans, &c., the Lighting Committee estimates that it will have on March 31st next a credit balance of over £900. This balance would be greater but for the fact that the period covered by the estimate involves the most expensive quarters of the year.

**Edinburgh.**—The Town Council has resolved that an application be made to the Secretary for Scotland for the borrowing of a further sum of £210,000 for extension of works under the Edinburgh Electric Lighting Order, 1891.

**Elland.**—The District Council has instructed Mr. W. Emmott, Halifax, to prepare plans, &c., with a view to obtaining a provisional order.

**Eton.**—The public lighting of Eton College and town will shortly be undertaken by the Windsor Electric Company.

**Exmouth.**—The District Council has resolved to apply for a provisional order for electric lighting.

**Gosport.**—The District Council has resolved to apply to the Board of Trade for a provisional order to supply electricity within the districts of Gosport and Alderstoke. It was stated that the Electrical Distribution Company is still willing to lease the order from the Council.

**Grays.**—Mr. A. H. Preece has advised the District Council that the proposal to supply electricity to neighbouring parishes is undoubtedly a good one, and if carried out would benefit both Grays and its neighbours. The Council is in communication with the Board of Trade regarding the matter.

**Hackney.**—The Vestry has selected a site for the new electricity works on a cut from the River Lea. It is intended to use water from the cut for condensing purposes.

**Hyde.**—The Town Council has unanimously passed a resolution to the effect that application be made to the Board of Trade for a provisional order to supply electricity for any public or private purpose within the borough.

**Inverness.**—The Town Council has finally decided to adopt steam-power for the electricity works, and has instructed Mr. Craven to prepare a scheme, on the understanding that he will sever his connection with the Brush Company.

**Italy.**—A central electric power station has lately been established at Lama dei Peligni. Water-power is utilised, the electric energy generated being employed for lighting purposes in the town named and surrounding district.

**Kilmarnock.**—The Town Council has appointed a committee to carry out the electric lighting scheme, for which a provisional order has been obtained.

**Kincardine-on-Forth.**—The residents are considering a proposal to light the town by electricity, generated with Dowson gas. Mr. W. T. Parves, M.I.C.E., has drawn up a report on the subject.

**Liversedge.**—The District Council has resolved to promote an application to the Board of Trade for a provisional order authorising it to supply electrical energy in the district.

**Mile End.**—The County of London and Brush Provincial Electric Lighting Company has given notice to the Mile End Vestry of its intention to commence the work of laying mains; the Highways Committee, however, in view of the fact that the company has made no effort to carry out its order during the last two years, has decided to ask the Board of Trade to revoke the order, and to request the London County Council to support its action.

**Newark.**—The Town Council has decided to apply for a provisional order, and to have a public meeting of ratepayers. The report of Mr. Vesey Brown shows that the probable cost of carrying out a lighting scheme would be £16,000.

**Northallerton.**—A small electricity works has been put down by a company for lighting and power supply to the town and district. A noteworthy feature is the use of aluminium for the overhead cables, of which there are about 5 miles; it is stated that the cost was 20 per cent. less than that of copper. This is probably the first instance of its use for this purpose in England.

**Peterborough.**—Applications are under the consideration of the Town Council to allow overhead wires for the purpose of a private electric supply to some of the business establishments of the town outside the area which the Corporation have scheduled in their proposed electric light works.

**Radcliffe.**—The District Council has received a letter from the Local Government Board sanctioning the borrowing of £1,100 for the purchase of land, and £14,900 for other works in connection with electric lighting in Radcliffe.

**Shoreditch.**—At a meeting of the Vestry on Tuesday, Mr. N. Moss, in moving the reception of the accounts of the electricity and dust destructor undertaking during the year ended March 25th last, stated that they had been made out as fully as possible. Every information had been given by Mr. E. A. R. Adams, the accountant to the Vestry, and he thought great praise was due to him for the way in which the accounts had been presented. As the details had only been in the hands of the members for a day or two, and they had not had sufficient time to examine the figures, he suggested that the consideration of the question should be adjourned until the next meeting. It was decided to adopt this suggestion, and to formally receive the accounts. According to the revenue account of the electricity works a gross profit of £7,478 was made, and after deducting the payment of interest and principal there remains a surplus of £5,682. There does, however, not appear to be any sum debited against this for the steam received from the refuse destructor. The total number of units sold increased from 284,295 in 1898 to 1,031,348 in 1899, and the total maximum supply demanded advanced from 408 KW. to 720 KW. in the same period.

The Vestry has completed three blocks of artisan's dwellings, which are fitted with electric light; the charges for the latter are 10d. for three rooms and 8d. for two rooms per week.

**Shrewsbury.**—The Town Council intends to adopt street lighting by electricity, and has resolved that the extensions should be carried out before the winter sets in.

**Southend.**—In spite of the vote recently cast by the town's meeting in favour of a municipal electricity supply, the Electric Lighting Committee has again recommended the Corporation to hand over its powers to Mr. Gibbings; as the latter stated not long ago to his council at Bradford, that he had withdrawn his offer, we await developments with interest. Meanwhile, we hear that four other companies have given notice of application for powers.

**Southport.**—In response to an advertisement by the Birkdale District Council, the Town Council is debating whether to offer to undertake to supply Birkdale with electricity at the same price as charged for the time being in Southport.

**Sowerby Bridge.**—The District Council has resolved to make application for a provisional order for electric lighting in the Council's gas area.

**Ventnor.**—The District Council has accepted the offer of the Electric Lighting Company to light the town with arc and glow lamps, *provided* that the company agrees to reduce the price of the arcs from £16 10s. to £15 per annum. Failing this the Council will negotiate with the gas company.

**Wednesbury.**—The Council has decided to light the main streets with electricity.

**West Ham.**—Mr. Steinitz has reported to the Electric Light Committee that a four-roomed house could be wired and fitted with five lights at a cost of 10s. per light, and that a charge of 6d. per week added to the rent would be sufficient to pay for the electricity consumed, as well as the interest on capital cost. The report bears more especially upon the question of lighting municipal dwelling houses.

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Airdrie and Coatbridge.**—The Councils are preparing a joint scheme of electric tramways, and have instructed Mr. Kennedy to frame a Bill granting powers to carry out the undertaking.

**Austria.**—A preliminary concession has been granted in respect of a projected electric railway between Zabrzech and Schonbrunn.

**Bath.**—The City Council has approved of the amended scheme for the electric tramways, comprising about 20 miles of single track and 40 cars, and will apply in November for powers to carry out the project. The capital required will be about a quarter of a million.

**Bootle.**—The Borough Council has resolved that application be made to the Board of Trade for a provisional order authorising the construction of seven additional tramways in the borough, with power to work the same by electric traction.

**Bradford.**—The Tramways Committee recommended the acceptance of Messrs. Demerbe & Co.'s tender for supplying and laying the tracks for the tramway extensions and the light railway to Stanningley, on the "Demerbe" patent system. Several members of the Council objected to this, on the ground that Messrs. Demerbe, being a Belgian firm, were not subject to the fair contracts clause, while their employés worked longer hours for less pay than was customary in England. The rails were not in accordance with the specifications, and weighed only 77 lbs. per yard instead of 105 lbs., as asked for. It was explained that only two English firms tendered, and neither tender conformed to the specification; the committee had invited the Demerbe Co. to tender separately, having found that the experimental section laid on this system in Leeds Road cost nothing for repairs, while the girder rails cost £90 per mile per annum. Other arguments were put forward, but the Council eventually rejected the recommendation. The Demerbe rail is shaped like an inverted U, the hollow being filled up with concrete continuous with the foundation.

**Brighton.**—Mr. J. Kincaid has reported to the Tramways Committee on the proposed electric tramways, recommending a 3 feet 6 inches gauge.

**Canal Haulage.**—The Leeds and Liverpool Canal Company are about to experiment with the Thwaite-Cawley system of electric haulage on a portion of their canal, about a mile in length, near Wigan.

**Chatham.**—The Board of Trade has authorised the construction of light railways for the districts of Chatham and New Brompton by the "Chatham and District Light Railways Company, Limited," which has been formed with a capital of £150,000. Rochester declined to participate in the scheme. The district is thickly populated, and is greatly in need of transport facilities. The charges will be moderate, and workmen's cars will run each way daily at low rates.

**Chester.**—The Corporation is considering the question of the acquisition of the tramways, as the company's lease is about to expire. The price asked for the tramways undertaking amounts to a total of £35,320. The company is desirous of obtaining a lease of the tramways, after their being relaid by the Corporation for working by electricity; this would be obtained from the Corporation's supply at the company's expense.

**Chorley.**—A syndicate has under consideration the construction of an electric tramway 9 miles in length, from Adlington through Chorley to Bamber Bridge, in Lancashire, and negotiations in connection with the scheme are in progress. The authorities whose interests are affected are the Chorley Corporation, the Chorley Rural District Council, and the Adlington Urban District Council. The Rural Council named has just appointed a committee to confer with the Chorley Corporation as to united action. The line will probably be an extension of that which has already been decided on to connect Bolton with the railway town of Harwich, and as it will terminate within 3 miles of Preston, there are hopes that one continuous system will eventually be constructed from Bolton to the latter town.

**Collisions.**—Two accidental collisions took place last week at Liverpool and Ashton, between electric cars and lurries, the latter in each case being loaded with alcoholic liquors. In the first case, the trolley car was not much damaged, though many bottles came to grief; but in the second instance, the front of the car was bulged in and a passenger injured.

**Driffield.**—Mr. Ward Thomas, with Mr. Fawcett, has attended one of the meetings of the Highway Committee, and given a short outline propounded by the Drake & Gorham Electric Power and Traction Company, Limited, who asked permission and assistance in applying for a light railway from Driffield to Beeford, a distance of some 9 miles. After hearing these gentlemen, the Committee were of opinion that in the interests of the town of Driffield the Council should approve of the proposed light railway. The Council adopted the Committee's views unanimously.

**Dublin.**—Another tram accident is reported from Dublin; this time a collision with a load of hay. According to the *Dublin Express*, the car pushed the hay cart a distance of 15 or 20 yards: the cart then collapsed, and the car left the track. No one was hurt, but traffic was delayed for an hour. Seeing that an electric car running at full speed can stop in its own length, how was it that the cart was pushed so far? Did the driver lose his head and turn the handle the wrong way?

**Leeds.**—The Tramways Committee, having in view the popularity and financial success of the electric cars, intends to adopt the same system on all routes; a meeting is to be held on 24th inst. to definitely settle the matter. The total receipts for August were £12,052 5s. 1d., as compared with £10,272 7s. 10d. last year.

**Newcastle.**—The Corporation has adopted the report of the new Tramways Committee in favour of installing the overhead trolley system throughout the city.

Mr. C. Hopkinson has reported on the alterations necessary for the Gosforth car-sheds, and has presented plans for sheds to hold 100 cars at Walker. The Corporation last week decided to order 70 single-deck and 30 double-deck cars, to carry 26 and 44 passengers respectively. In accordance with Mr. Hopkinson's recommendation, the tender of Mr. Thomas Beeley, of Hyde, for six Lancashire boilers, economiser, &c., was accepted at the price of £7,298; the engineer's report on the city lighting with 110 arc lamps, costing £18 each per annum, was also approved.

**Paisley.**—The Town Council is desirous of purchasing the tramways and introducing electric traction, and is negotiating with the tramway company with that object.

A motion to take over the tramways and develop them as a municipal scheme was defeated by a large majority.

**Scarborough.**—The Parliamentary Bills Committee has decided to defer the question of introducing electric traction in the borough for a year or two.

**Sheffield.**—The traffic on the electric tramways has already increased enormously; on the Nether Edge route there were three times as many passengers during the first week of electric traction as there had been previously. We hope this is not merely due to curiosity.

The tramcars commenced running on the Walkley route on the 18th inst.; a 12 minutes' service was provided.

**Southport.**—On Tuesday a public meeting was held at which Mr. Scotter, M.I.C.E., engineer to the proposed light railway between Southport and Ormskirk, explained the scheme. A half-hour service will be given.

**Wallasey.**—On Tuesday Colonel Marsh and Dr. S. W. Wheaton, inspectors under the Local Government Board, held an inquiry at Egremont regarding the application of the District Council to borrow £18,500 for electric tramway purposes under the Local Improvement Act of 1899. The money is sought at present for the installation only, and not for rolling stock. There was no opposition.

**Walsall.**—The Council has resolved that, in the event of failure to constitute a joint board of representatives of the Walsall and Wednesbury Borough Councils and the Darlaston District Council for acquiring and working the tramways in Walsall and Darlaston, the Corporation should obtain powers to purchase and work the whole of the tramways in the borough, as well as extend the same to the borough boundaries. This would involve the construction of 13½ miles of tramway, at an estimated cost of about £50,000; the tramways would then connect with the Birmingham and Wolverhampton tramways.

## TELEGRAPH AND TELEPHONE NOTES.

**The All-British Cables to Australia.**—We gather from the Australian press that we were not mistaken in our opinion that the Eastern Extension Telegraph Company would attempt to average matters so that if possible the right to "*viâ*" unrouted telegrams should come into the hands of their employés. The *Sydney Morning Herald* says:—"Speaking in regard to the proposed Cape cable, the Eastern Extension Company's representative here said to-day that the concession required by the company was unimportant to the Colonies, but important to the company. At present they paid a terminal rate to the Governments, who, in return, provided operators, and delivered messages. What the company desired was that they should pay the Government a fixed rate per mile for the telegraph line used. That would mean that they would have the right to use the wire from Adelaide to Melbourne at £5 a mile, or £2,500 in all per year. They could then put on their own operators and employ their own messengers, which would be a saving to the Governments, and would place them in direct touch with the public, with little or no loss to the revenues of the Colonies."

That these offers are appreciated at their true value is shown by the following Melbourne telegram to the *Times*:—

"The proposals of the Eastern Extension Company to lay a cable between South Africa and Australia, and to reduce the telegraphic charges on condition that they are allowed to open an office in Melbourne for the receipt and despatch of messages, have been discussed by the Victorian Assembly. Mr. Duffy, Postmaster-General, said that he had refused permission pending a consultation with England, Canada, and others interested in the Pacific cable proposals. The Eastern Extension Company intended to destroy the Pacific scheme. Mr. Gillies strongly supported Mr. Duffy, and said that it would be a tremendous mistake to alienate the British Government by playing into the hands of a company which had previously refused reductions at a time when competition was not feared."

**Canadian Telegraphs.**—The *Times* correspondent at Ottawa reports that a contract has been awarded for the extension of the Government system of telegraphs along the north shore of the Gulf of St. Lawrence to Chateaux Bay (Labrador) and Belle Isle. The completion of the line will enable incoming vessels to be reported two days earlier that at present.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| Amazon Company's cable—Cable beyond Gurupa... | April 4th, 1898 ... | ... |
| Latakia-Cyprus ... ... | June 20th, 1899 ... | ... |
| Otranto-Corfu ... ... | Sept. 16th, 1899 ... | |
| Corea-Japan ... ... ... | August 7th, 1899 ... | ... |
| Cheik Saiid-Perim ... ... | Sept. 3rd, 1899 ... | Sept. 17th, 1899. |
| Jamaica-Colon ... ... | June 30th, 1899 ... | ... |
| **Landlines.** | | |
| Communication between Salonika and Monastir ... | March 23rd, 1899... | ... |
| Communication between Bolama-Bissao ... ... | July 28th, 1899 ... | Sept. 9th, 1899. |
| Lines from Haiti to Gonaives, Gros Morne, Port de Paix Plaisance, and Cape Haitien, Port au Prince to Miribalais and Jacmel ... ... | August 18th, 1899 ... | ... |
| Moulmein-Bangkok ... ... | Sept. 15th, 1899 ... | Sept. 16th, 1899. |
| Saigon-Bangkok ... ... | Sept. 12th, 1899 ... | Sept. 19th, 1899. |

**Huddersfield Telephone License.**—A letter was read at the last meeting of the Cleckheaton District Council from the Postmaster-General intimating that the Huddersfield Corporation had applied for a license to establish an independent system of telephones within the Huddersfield area of the National Telephone Company's

system, and asking to be informed whether the Council would approve the application, Cleckheaton being partly within the Huddersfield area. The subject will be considered by a Special Committee in conjunction with the Postal Committee of the Chamber of Commerce.

**Wireless Telegraphy.**—An Adelaide paper says that for some time Sir Charles Todd and Prof. Bragg have been making experiments in wireless telegraphy with a view to its utilisation for communication with the Althorpes and other outlying stations. During the past few weeks many messages have gone to and fro between the Observatory on West Terrace and the temporary station at Henley Beach. The sending and receiving instruments, including the coherers, made after Marconi's pattern, have been gradually improved, until now long sentences can be sent through with very few mistakes. It is intended shortly to carry out experiments in the Gulf, and good results are hoped for. A curious and interesting effect was observed the other day. Messages from Henley Beach were being received at the Observatory. In the instrument-fitter's room at the Post Office, Mr. Uabehaun was making some improvements to his receiving set, and as an experiment he connected it to the Henley Beach telephone wire. He was surprised to find that he could get some of the signals. Apparently the telephone wire had picked them up and guided them into the Post Office. The telephone wire was at the time being used for ordinary business. The coherers were made by Mr. Rogers at the University of Adelaide.

The daily Press says that experiments connected with wireless telegraphy are being made, not, however, by the local authorities themselves, between the works at Mount Pleasant and the General Post Office. Further and more important trials will shortly be carried out.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Barking Town.**—October 24th. The District Council wants tenders for boilers, pipe work, two 100-kw. steam dynamos, switchboard, motor and trailer cars, trucks and electrical equipment, overhead equipment, underground feeders, conduits, road work, &c., for the Barking and Beckton light railways. See "Official Notices" September 1st.

**Belfast.**—September 31st. The Electric Committee wants tenders for c.i. floor plates and w.i. rails for the electric light department. Specifications from the city electrical engineer on payment of one guinea, returnable as usual.

**Belgium.**—Tenders are being invited until the 27th inst. by the Belgian Government authorities in Brussels, for the supply of four sets of Hughes printing telegraph apparatus. Tenders are to be sent to La Bourse, Brussels, whence particulars may also be obtained (cahier des charges special No. 22).

**Birkenhead.**—September 29th. The Corporation wants tenders for boosters, switchboard, accumulators, cables, and laying same. See "Official Notices" September 15th.

**Bray.**—October 2nd. The Urban District Council wants tenders for 12 months' electrical supplies. See "Official Notices" this week.

**Cardiff.**—September 27th. The Corporation wants tenders for cast-iron arc lamp-posts. See "Official Notices" September 15th.

**Darwen.**—September 25th. The Corporation wants tenders for a high speed vertical engine and dynamo (300 to 350 kw.); also switch work. See "Official Notices" September 8th.

**Dundee.**—September 28th. The Town Council wants tenders for 10 double-decked single and 10 double-decked bogie truck cars, all electrical. See "Official Notices" this week.

**Germany.**—October 16th. Tenders are being invited by the municipal lighting and tramway authorities of Königsberg, Prussia, until October 16th, for the supply of six boilers required in connection with the extension of the electric power station, to supply steam to new engines aggregating 1,800 e h p. Tenders to be sent to Die Direction der Städt, Belenchtungswerke und der Electr. Strassenbahnen Kaiserstrasse 41, Königsberg, Prussia, whence particulars may be obtained for 1s.

**Glasgow.**—October 10th. In connection with the tramway scheme the Corporation wants tenders for switchboards, fuel economisers, two 50 and one 30-ton electric travellers, power station steel work, and cables. See "Official Notices" September 8th.

**Glasgow.**—October 10th. The Corporation wants tenders for the reconstruction of tramways according to specification. See "Official Notices" this week.

**Huddersfield.**—October 2nd. The Corporation wants tenders for five Lancashire boilers. See "Official Notices" September 15th.

**Ilfracombe.**—September 25th. The District Council wants tenders for boiler plant, engine plant, dynamos, condensers, switchboard, mains, lamp-posts, accumulators, meters, crane, buildings, &c. See "Official Notices" August 18th.

**Leeds.**—October 18th. The Council wants tenders for 50 electric tramcars. See "Official Notices" this week.

**Leeds.**—The Council requires tenders for 50 electric tramcars. Particulars, &c., may be had on application to Thomas Newson Esq., M.I.C.E., city engineer, Municipal Buildings, Leeds. Tenders must be to hand not later than noon, October 18th.

**Llandilo.**—September 28th. The Council wants tenders for the lighting of the town by electricity. See our "Official Notices" this week.

**Oldham.**—The Electric Light Committee invites tenders for rolled steel girders, concreting, and other works required in the foundations for "Klein's Tower Water Cooler" at the electric light station, Gas Street, Oldham.

**Rotherham.**—October 9th. The Corporation wants tenders for Lancashire boilers, engines, dynamos, piping, condenser, economiser, battery, switchboard and boosters, feeders, mains, road work, &c., for electric lighting. For particulars see "Official Notices" September 8th.

**Runcorn.**—September 27th. The Urban Council is inviting offers for the electric lighting of the district, to be sent to the chairman of the Highways Committee.

**Russia.**—The municipal authorities of Perm are at present inviting tenders for the concession for the establishment and exploitation of a central electric lighting station in the town.

**Russia.**—Tenders are being invited until October 2nd by the municipal authorities of Tiflis (Caucasia) for the concession for the working of the tramway system in the town and for the extension of the same. The existing lines consist of about 21 kilometres of horse tramways, which are to be converted to electric traction. While 15 kilometres of new electric lines are also to be constructed.

**Salford.**—September 28th. The Corporation wants tenders for 16 Lancashire boilers and superheaters. See "Official Notices" September 15th.

**South Wales.**—September 28th. The proprietors of Margam Copper Works, Port Talbot, wants tenders for the electric lighting (arc and incandescent) of their works. See "Official Notices" September 8th.

**Spain.**—The municipal authorities of Ledana (Cuenca province) are inviting tenders until the 26th inst. for the concession for the electric lighting of the town during a period of five years. Particulars may be obtained from, and tenders are to be sent to, El Secretariat del Ayuntamiento de Ledana (Cuenca).

**Swansea.**—October 9th. The Corporation wants tenders for medium speed vertical engines, continuous current generators, booster and balancer. See "Official Notices" this week.

**Sydney (N.S.W.).**—November 3rd. The Municipal Council of Sydney is inviting tenders for the construction and erection of a refuse destructor for treating 60 tons of refuse per day (24 hours).

**Warrington.**—September 30th. The Committee of Visitors of the Winwick Asylum, near Warrington, invites tenders for Contract No. 1.—Generating plant, including three sets of condensing engines or turbines, with directly coupled dynamos, each of 100 kw. output at 220 volts, booster set, motors, surface condensers, cooling tower, steam and exhaust pipes, &c. Contract No. 2.—Switchboard. The drawings can be inspected and specifications obtained of J. P. Muspratt, Clerk to the Committee of Visitors, County Offices, Preston, on payment of £2 2s for each specification, returnable. A separate tender must be sent in for the work included in each specification. See "Official Notices" September 8th.

### CLOSED.

**Brighton.**—The tender of the Private Wire and Telephone Installation Company has been accepted for installing a system of telephones throughout the new municipal buildings at Brighton. Instruments on the inter-communication system will be fitted in all the offices of each department, and, in addition, communication will be established between all the heads of departments.

**Bristol Lunatic Asylum.**—The Visiting Committee has accepted the tender of Messrs. F. W. Ball & Co., for the wiring and fitting of the asylum for electric light, at a cost of £1,645.

**Carlisle.**—The contract for boilers for the City Council electricity works has been given to the Oldham Boiler Works Company at £1,690, that for the engines and dynamos having been given to Messrs. D. Bruce Peebles & Co. at £5,710.

**Clerkenwell.**—The Vestry has decided to light the library by electricity, and the tender of Messrs. Barlow Bros. & Co., of Shaftesbury Avenue, has been accepted for carrying out the fitting work.

(*Continued on page* 483.)

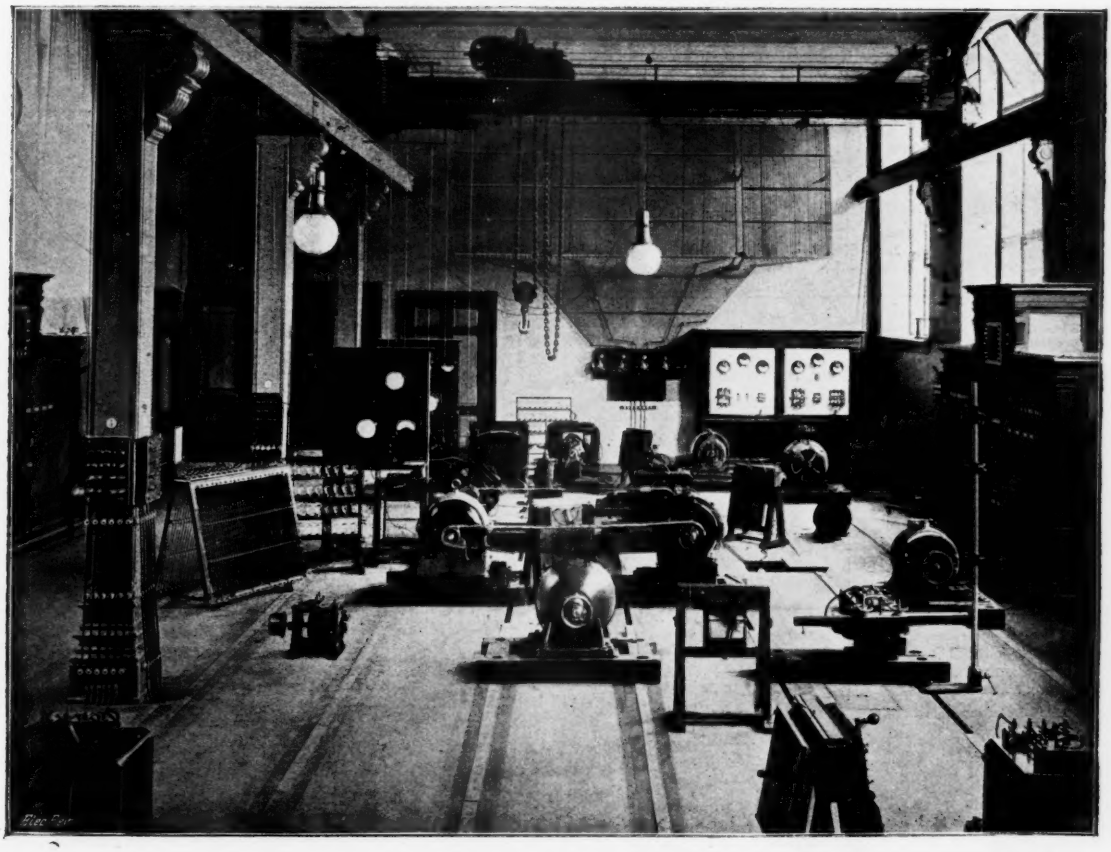
## A GERMAN ELECTRO-TECHNICAL INSTITUTE.

Prof. E. Arnold has recently written a 60-page book describing the Electro-technical Institute at Karlsruhe, Germany. It is common knowledge that the technical institutes of Germany are better endowed and better equipped than our own, and their especial aim is to train men who have shown special promise in their earlier education. As Mr. Carnegie has pointed out, it is not the average men who are wanted nowadays, but men who can lead. In this country we appear to go out of our way to train and nurse mediocrities by the hundred, and dishearten and crush back to a dead level the more promising young men. Anybody who cares to inquire will find that all the best electrical work in America, or on the Continent, has been done by men not yet out of their thirties, and if this country is to recover its lost ground, or stop losing more, which is what we must now hope for, then we must give the best opportunities and positions of responsibility to the brightest of our young men.

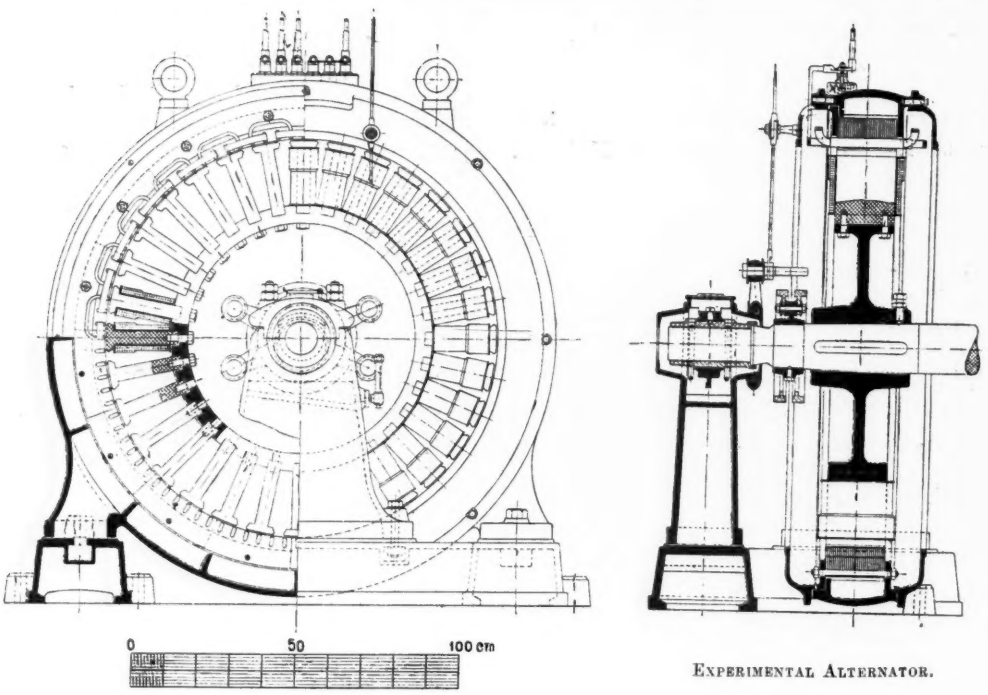
The Electro-Technical Institute at Karlsruhe, Germany.

The illustrations herewith will give some idea of the thorough way in which the Germans equip their technical institutes. They are not patchwork affairs depending on the charity of certain guilds companies, or private individuals, but are properly endowed Government institutions, and, as such, are a standing monument to the common sense of the German nation.

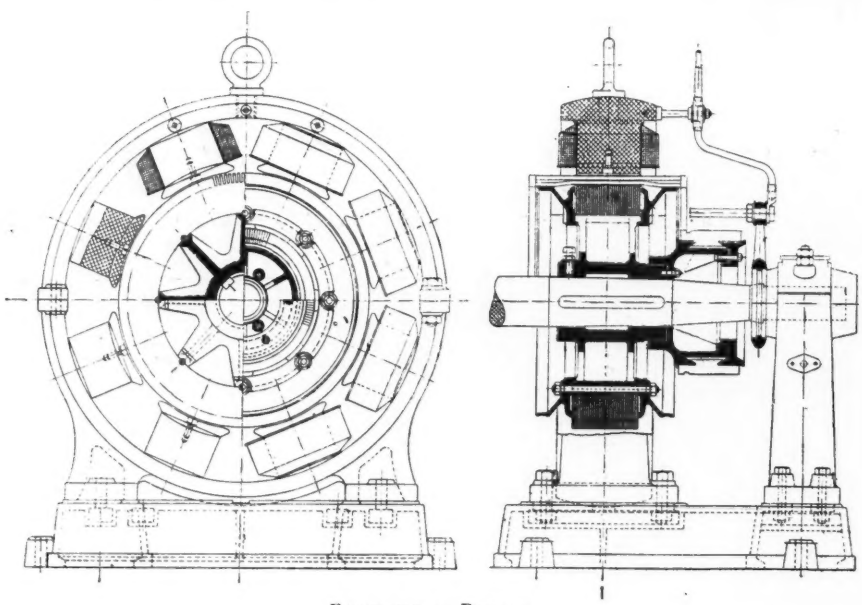
It must be remembered that this Institute does not set out to teach *all* the trades and professions from the making of a suit of clothes, or a model engine, to shorthand and music. It is purely



Testing Room, Karlsruhe Institute.




Experimental Alternator.



Experimental Dynamo.

## Particulars of Experimental Motor-Alternator. Karlsruhe Institute.

Alternator. ·8 kw.

1,350 revolutions.
75 or 150 volts.
10 or 5 amperes.

*Armature.*

Bore, 200 mm.
Length of core, 140 mm.
Total depth of core, 60 mm.
Total number of turns, 2 × 72.
Area of conductor, 1·8 sq. mm.
Number of tunnels, 16
Diameter of tunnel, 22 mm.

*Magnet.*

Diameter, 195 mm.
Number of turns, 4 × 1,050.
Size of wire, ·7 mm. bare,
" 1·1 mm. insulated.

Continuous current motor.

1,350 revolutions.
110 volts.
12 amperes.

*Armature.*

Diameter, 130 mm.
Length of core, 130 mm.
Total depth of core, 50 mm.
Number of conductors, 297 × 2.
Size of conductor, 1·1 sq. mm.
(two in parallel)
Number of slots, 33.
Depth of slot, 13 mm.
Breadth of slot, 6 mm.

*Magnet.*

Bore, 135 mm.
Number of turns, 2 × 3,200.
Size of wire, ·75 mm. bare.
" 1·00 mm. insulated.

## Particulars of Experimental Alternator and Dynamo. Karlsruhe Institute.

Multiphase alternator.

188 revolutions.
110 volts.
22 kw.

*Armature.*

Bore of armature, 120 cm
Length of armature core, 18 cm.
Total radial depth of armature core, 9 cm.
Number of tunnels, 96.
Number of hours per phase, 192
Wires per tunnel, 12.
Diameter of wire, 3·5 mm.

*Magnets.*

Diameter over magnets, 119·2 cm.
Face of pole, 8·5 cm.
Turns per pole, 200.
Diameter of wire, 3·7 mm.

8-pole continuous current dynamo.

188 revolutions.
110 or 170 volts.
22 kw.

*Armature.*

Diameter of armature, 76·2 cm.
Length of core, 20 cm.
Total depth of armature core, 12 cm.
Number of conductors, 346
Size of conductor, ·35 × 1·2 cm.
Number of slots, 173.
Depth of slot, 2·9 cm.
Width of slot, ·55 cm.
Number of commutator segments, [173.

*Magnet.*

Field bore, 77 cm.
Face of pole, 24 cm.
Width of pole, 19 cm.
Diam. of magnet pole, 19·5 cm.
Turns per pole, 700.
Diameter of wire, 2·5 mm.

and simply an electro-technical institute, and to properly appreciate this fact, it is interesting to compare the size of the town of Karlsruhe with similar sized towns in this country. Karlsruhe is about 350 miles from Berlin as the crow flies, and has a population of about 74,000. Wolverhampton, 200 miles from London, has a population of 83,000; Middlesbrough has a population of 76,000; Greenock, 69,000; St. Helen's, 72,000; Walsall, 72,000; Rochdale, 72,000; Leith, 68,000; Cork, 75,000.

## ENGINES FOR ELECTRIC TRACTION.

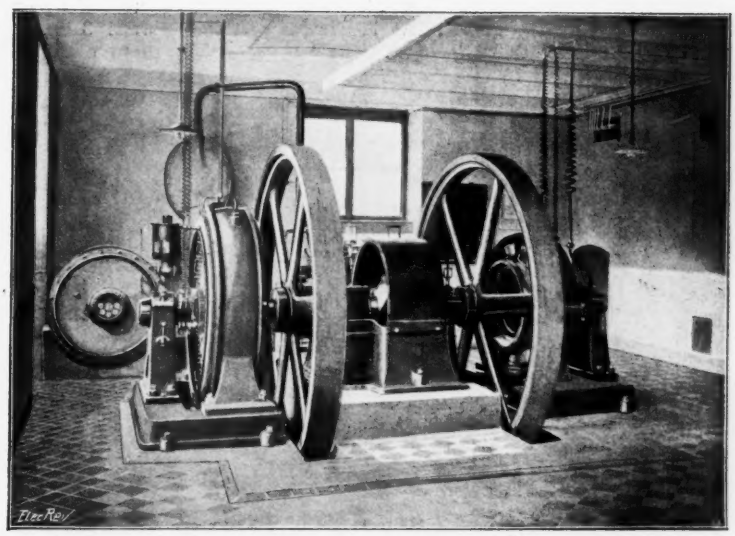
We are indebted to the *Engineer* for particulars of some large Allis engines, very similar in size to those called for by Glasgow, for they have cylinders 46 inches and 86 inches × 60 inches stroke, and thus compare approximately with the Glasgow engines —44 inches and 88 inches × 60 inches. The shaft of these engines is 34 inches diameter in the bearings, as compared with the 32 inches asked for by Mr. Parshall.

Mr. Parshall has made professions that he was anxious to let the Glasgow work to an English firm. To our simple minds there appear so many things inexplicable in print about the whole Glasgow business, that we would ask our readers to study the Allis engines as described in the *Engineer*, and Mr. Parshall's specification, and find their own way out of the maze.

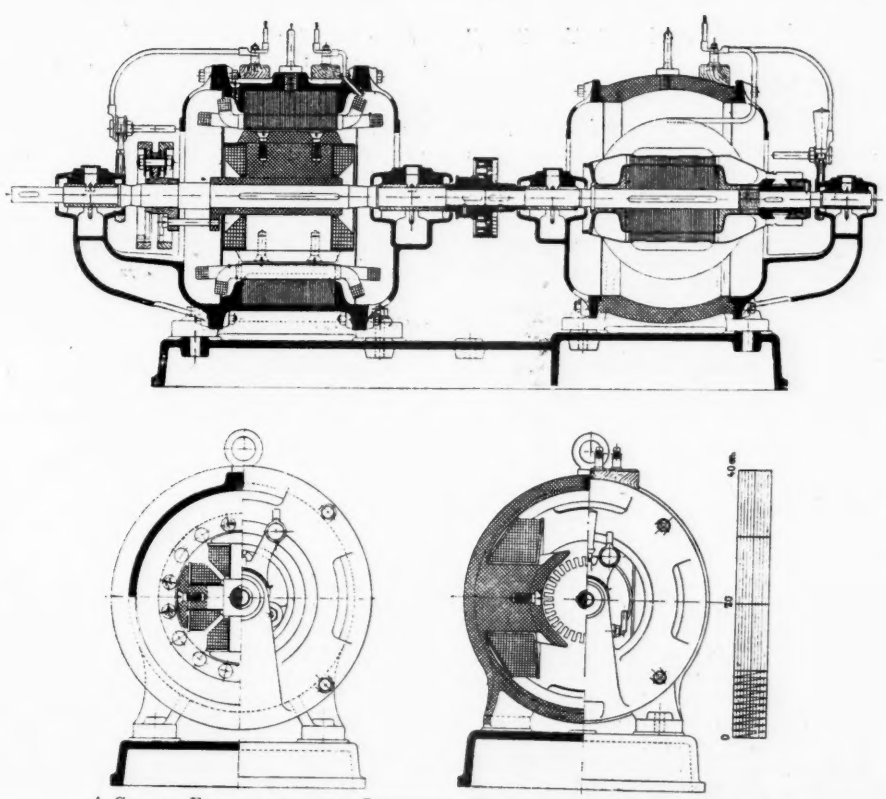
The *Engineer* returns to the question of the abnormal shaft diameters of the engines it illustrates, that are to be supplied to the Metropolitan Street Railway Company of New York.

The shaft, as nearly as we can measure from the uneven scale of the illustration, is fully 14 feet between bearings, or, say, 19 feet from centre to centre of bearings. If we examine this by certain rules used in Lancashire for determining the middle diameter of a heavily loaded shaft, we find that this 37-inch shaft—it is 37 inches diameter at the wheel swell—works out at very different diameters for a load of 180 tons. The 180 tons is double the weight of the fly-wheel, to allow for the armature, which is hardly likely to be heavier than the wheel, nor do these two loads represent a central load in the sense that a single wheel does.

One rule for heavily loaded shafts is $D = \sqrt[4]{\frac{W l^2}{6}}$

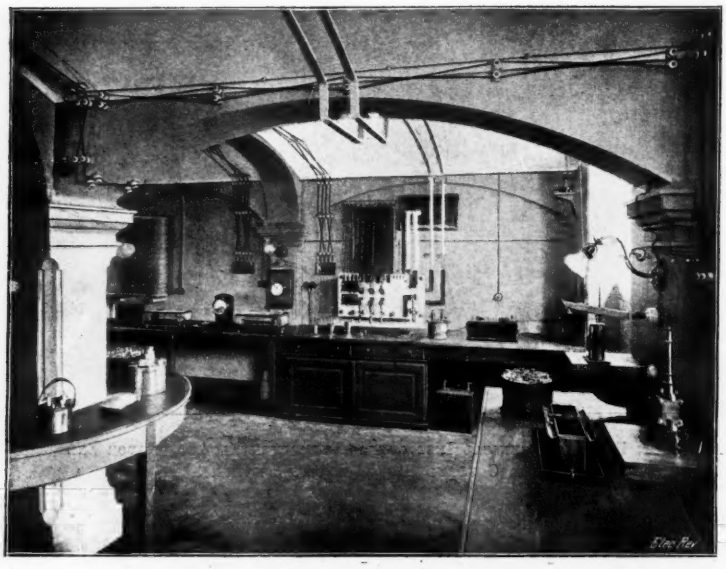


A German Electro-technical Institute.—Experimental Alternator and Dynamo Coupled Direct to Gas Engine.



A German Electro-technical Institute.—Experimental Motor-Alternator.

where D = central diameter in inches, and $l$ is the span of the shaft in inches between centres of bearings, W being the load in tons. Then, with the above dimensions, D comes out as 35½ inches. There appears to be a fallacy in this rule, involved in the use of the fourth root, but this is not so, the shaft being treated as a beam. At 100 inches span the diameter would work out at 23½ inches.



A German Electro-Technical Institute.—The Standardising Room.

Taking the other rule, given in "Kempe's Year Book,"

$$D = 3\sqrt[3]{\frac{W\,L}{2}}$$

where L is the span in feet.

This rule gives D = 36 inches for a 19-foot span, and D = 27 inches for a span of 100 inches. Apparently the shaft is not enormously over-strong for such a huge span.

It is well recognised that trouble ensues where long span shafts are heavily loaded, and English practice has been to keep the span short, and we believe that the first of the above rules was found satisfactory for ordinary practice, the second rule having been worked out for general application. For the New York engines we cannot say that the dimensions are so very great, but we do consider this American design excessively faulty in having such an enormous span, demanding such a huge diameter of shaft.

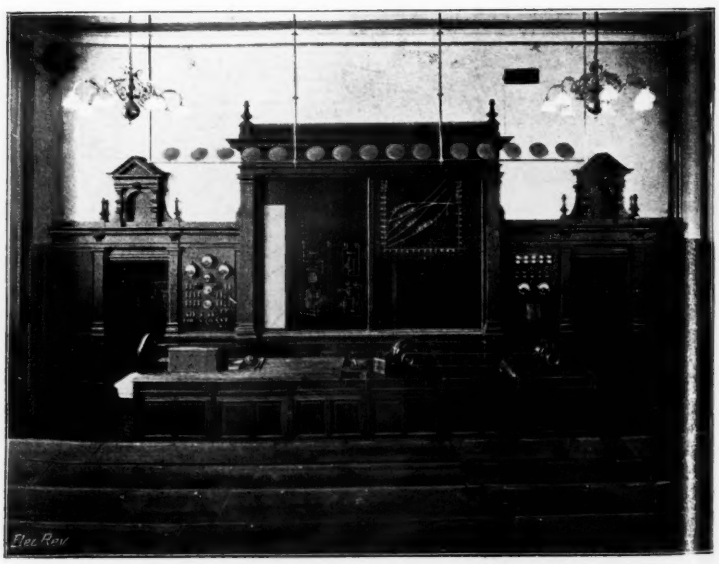
The cylinders are 28 feet 6 inches between centres, an altogether unnecessary span, and one which if employed in the past is quite sufficient to have led up to the excessive shaft diameters now in vogue.

But Mr. Parshall must be acquitted of this error until we see plans to the contrary. His design did not include a fly-wheel and a generator on the same piece of shaft. There was to be a bearing between of a length of 64 inches. The span for the fly-wheel length between centres does not appear to have been required to exceed 9 feet by the design for the engine as described, and for this span and only 105 tons of load, the central diameter works out by rule No. 2 at 24½ inches, and indicates that the Glasgow shaft is abnormally and excessively large. Mr. Parshall appears to have drawn his dimensions from one style of American practice and applied them to another type of engine, somewhat after the manner of the proverbial Chinaman and the patched new breeches. The illustration of the Allis engine for New York serves to confirm our opinion that the Glasgow dimensions, though almost identical, are excessive. We look upon the New York shaft as not too strong for the bad design as regards span.

We quite agree with the *Engineer* that the bearing surfaces are excessive. Our contemporary calculates them at 108 lbs. per square inch of projected area. We have observed that the heavy rope drums of Lancashire are carried on bearings having an area of about 1 inch for each 130 lbs. of load. The *Engineer* asks why American practice demands such enormous bearings to run cool enough when its own figure deduced from steamship practice is 224 lbs., while even 600 lbs. per square inch may be carried with care. For its figure of 224 lbs, a bearing 22½ × 40 would suffice. We think, however, that the *Engineer* is on the wrong tack here in this item of the New York engines, for we do not consider that their shaft diameter is at all a matter dependent on bearing stresses, but entirely, in this case, of weight and span.

It has been pointed out to us by an able and experienced engine maker in America, that Americans generally do not make a success of gun-metal bearings, and prefer to use white metal, and this may have some influence in determining bearing areas.

Brought to a brief summary, we may say that bearing stresses are, as a rule, easily provided for in any size of shaft that can sustain the load of its fly-wheel; that diameters must be calculated from spans between bearings. Long spans deflect so much under load that they require the bearings to be inclined to suit this. For traction work, the maximum reading of the ammeter is to be taken as indicating the tortional stress, and this must be doubled, to allow for sudden application. We believe these points practically embody the correct design of shafts, and it is useless fixing the sizes for one engine from those found suitable in another engine of the same power, but with different spacing of bearings, &c.



A German Electro-Technical Institute.—Lecture Table.

As a matter of economy in all large shafts, the time appears to have come for some different method of supporting such heavy fly-wheels as are now used. The friction of a large neck is very great. The friction of large mill engines is said to be 20 per cent. It is as much as is saved by condensing, or by the most efficient feed heating, and it is chiefly the product of the fly-shaft bearings. In a

traction generator there is no side pull of belts in direct-connected sets, and the weight of the fly-wheel could be carried on friction wheels. It would not be insuperably difficult to so arrange these as to bear the heavy load, and transfer it to other bearings very much less in diameter, and very much slower in rubbing velocity.

It is not usual to calculate the slope of a loaded shaft. A formula for this is, however, $s = \frac{W l^2}{16 E I}$ where $s$ is the rate of slope, $l$ the span in feet, W the load in pounds, E = the modulus of elasticity or 26 millions, and I = $\cdot 0491 d^4$, $d$ being the diameter in inches. For W in tons, $s = \frac{W l^2}{70 d^4}$ where $l$ is the span in feet. Thus, for a load of 100 tons on a 10-foot shaft of 20 inches diameter, we get $s = \frac{100 \times 100}{70 \times 20^4}$ or $s$ = 1 in 1,120. The half length of the shaft bearing being, say, 30 inches, the slope of this will be about $\frac{1}{40}$th of an inch. Such a slope is too much; it implies far too serious a bending of the shaft. But the slope varies inversely as the fourth power of the diameter, and would be reduced to less than half by increasing this from 20 to 24 inches. The first of the rules given for central diameters was probably based on the fact that the rate of slope of a loaded beam is a function of the fourth power reciprocal of the diameter. Neglect to provide for such slopes by properly canting the bearings inwards has ruined many a new shaft.

It may be that the overheating of American shafts, due to this very fact, has been responsible for the present huge diameters, which might have been avoided had their bearings been made parallel with the necks they supported. That such has not been recognised by Americans is probable, or how else are we to account for the enormous spans they allow between bearings, and the fact that they permit such very small nominal bearing stresses?

Long span shafts gave trouble in Lancashire years ago, when made of the same diameter as had proved sufficient for toothed wheels before the wide rope drums were introduced. These soon brought about an increase of the middle diameter of the shaft, and promoted also an endeavour to minimise the span of the shafts as a girder, while the question of slope was dealt with by Hick-Hargreaves by the introduction of their swivelling bearings, a refinement that perhaps a careful erector might render unnecessary.

Shaft design and general arrangement is very much a question of compromise between antagonistic influences, and since the introduction of heavy wheels has had little to consider in respect of torsion, which is amply provided for when the other desiderata are taken into full account. There still remains, however, the question of a dead short circuit on the line resulting in an enormous current being taken from the generator more rapidly than the circuit breaker can cut the line out. On this assumption, which our correspondent, Mr. Taylor, seems inclined to make, but appears disinclined to put down plainly, but which other electrical engineers state is really the case, the circuit breaker does not protect the shaft from excessive torsion and the strongest shaft must fail. Obviously, therefore, the only correct system is to place a maximum slip coupling between the generator and the fly-wheel, or to design generators on the fly-wheel principle, avoiding entirely any transfer of fly-wheel energy through the shaft. We propose to return briefly to the question later.

## CONTRACTS CLOSED.

(*Continued from page* 478.)

**Colwyn Bay.**—The District Council has accepted the tenders of Mr. B. Thomas, Cornbrook Telegraph Works, Manchester, for electric lighting plant as follows. About 30 firms tendered for the various contracts:—

| | £ | s. | d. |
|---|---|---|---|
| Boiler and fittings | 466 | 0 | 0 |
| Feed pump, heater, tank, &c. | 236 | 18 | 8 |
| Steam and exhaust pipes and fittings | 150 | 0 | 0 |
| Steam dynamo, balancer, and boosters | 1,218 | 0 | 0 |
| Switchboard and connections | 291 | 15 | 0 |
| Accumulators | 775 | 0 | 0 |
| Cables | 542 | 0 | 0 |

**Crewe.**—The Town Council has given the contract for erection of electricity works buildings to Mr. J. Matthews, of Nantwich, at £6,000.

**Darwen.**—The Corporation is stated to have accepted the tender of the British Thomson-Houston Company and the Westinghouse Company for the supply of motor cars. The tenders submitted were:—

| | |
|---|---|
| British Thomson-Houston Company | £6,145 |
| Westinghouse Company | 6,145 |
| Brush Company | 6,700 |
| Dick, Kerr & Co. | 6,950 |
| Siemens Bros. & Co. | 10,075 |

**Leamington Spa.**—The contract for an extension storage battery, 65 cells, 1,800 ampere-hours capacity, for the Midland Electric Light and Power Company, has been secured by the Hart Accumulator Company.

**London.**—The Bermondsey Vestry on Monday considered tenders received for the fittings, &c., required for the electric lighting of the Town Hall, the contract comprising the existing buildings, the proposed extensions, and the alteration of the existing gas fittings in lieu of providing new electroliers. The totals of the tenders, which were given in detail, may be summarised as follows:—

| | £ | s. | d. |
|---|---|---|---|
| National Electric Wiring Company (recommended for acceptance) | 485 | 6 | 0 |
| A. H. Wood | 491 | 0 | 0 |
| Walsall Electric Lighting Company | 1,039 | 5 | 0 |
| Charles Peacock & Co. | 946 | 17 | 0 |
| The Concentric and General Contract Company | 653 | 10 | 0 |
| F. Troy & Co.* | 930 | 19 | 0 |
| Sweet Bros. | 675 | 16 | 0 |
| Laing, Wharton & Down | 914 | 5 | 0 |
| W. Mackie | 1,017 | 8 | 0 |
| H. Beard & Co. | 1,017 | 6 | 0 |
| Simmonds Bros. | 793 | 14 | 0 |
| Magnet Electrical Engineering Company | 823 | 17 | 0 |
| Thorpe & Salter | 914 | 0 | 0 |
| W. J. Bishop & Co. | 930 | 0 | 0 |
| Newsome, Pinching & Walter | 780 | 0 | 0 |
| Peto & Radford | 1,043 | 16 | 0 |
| W. J. Fryer & Co. | 862 | 15 | 0 |
| C. J. Grist & Co. | 1,094 | 1 | 4 |

* This tender includes the cost of new electroliers.

At a late hour of the evening the members of the Vestry were still engaged in discussing whether or not the proposed extensions of the Town Hall should be carried out. In case these are abandoned the amount of the tender recommended for acceptance would be reduced by £76 12s.

**London.**—The Shoreditch Vestry, on Tuesday, considered the following tenders for the supply and laying of 1,082 yards of 1·5 low tension lead-covered cable from Worship Street to High Street:—

| | £ | s. | d. |
|---|---|---|---|
| W. T. Glover & Co. (accepted) | 1,277 | 17 | 8 |
| British Insulated Wire Company | 1,313 | 13 | 9 |

**North Wales Counties Lunatic Asylum.**—The Committee of Visitors has accepted the following tenders:—For engines, dynamos, &c., Messrs. Donnison, Barlyn & Sillem, £2,111 10s.; for wiring, switchboards, &c., Messrs. Frank Suter & Co, London, £2,061.

**Southport.**—The contract for the supply of two 200 KW. tramway generators has been placed with Messrs. D. Bruce Peebles & Co., of Edinburgh, the price being £4,825.

**Sunderland.**—The Corporation has placed the order for four 215-KW. steam dynamos for the extensions of the electric light station, with the Sunderland Forge and Engineering Company, Limited.

**Swansea.**—The Tramways and Electric Lighting Committee last week considered a report presented by the sub-committee recommending the advertising for tenders for the supply of engines and dynamos, such to be sent in by October 9th; also the acceptance of the tender of Mr. David Jenkins, of Swansea, for the building of the electric lighting station. The amount of the tender was £17,242.

## NOTES.

**Institution of Electrical Engineers.**—Prof. Silvanus P. Thompson, F.R.S., president, and Prof. W. E. Ayrton, F.R.S., past president, having been invited to take part in the Volta celebrations at Como, have been chosen by the Council to represent the Institution as delegates on this occasion.

**Fatal Accidents.**—According to the *Scientific American*, six firemen, while working at a fire in Omaha, made contact through an iron-bound ladder with a high pressure overhead wire. Four of the men were killed, and the other two severely injured.

**A New Single-Phase Alternating Current Motor.**—We are given to understand that Mr. W. G. Rhodes, M.Sc., M.I.E.E, who is chief lecturer in Electrical Engineering at the Royal Technical Institute, Salford, has invented a new single-phase induction motor, which starts with a torque approximately equal to that exerted when running under full load. The principles involved in the construction of this motor have not yet been divulged, but we believe that Mr. Rhodes has constructed an experimental 1-H P. motor which gives a starting torque of about 21 lbs. on a 3-inch pulley. The full-load torque when running at a speed of 2,200 revolutions per minute is 20 lbs. The full load efficiency of the motor on a 100-volt 80 frequency circuit is stated to be 75 per cent., whilst the power factor is 0·70. The motor was constructed for experimental purposes, and it is expected that superior results will be obtained by improving its construction mechanically. As far as we know, this starting torque exceeds any hitherto obtained in induction motors. We hope to give full details of this machine in a later issue.

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**More American Works for England.**—We cull the following interesting paragraph from the *Glasgow Herald*:—"Several large American companies will this autumn follow the example of the Westinghouse Engineering Company and appeal for British capital to inaugurate works on American lines in this country. While these will be for the most part connected with electrical work, the number will include some of the bridge builders of the States, as they believe that their methods of working will enable them to compete successfully for bridge work in this country and the colonies, with all the patriotic advantages associated with British labour, even although many of the workmen are imported from the States. Switzerland is also being looked to as a centre for the establishment of American works, and the Baldwin Locomotive Company, of America, and Siemens & Halske, of Berlin, with others, have joined for the establishment of works to turn out annually 600 locomotives, 1,000 steam railway passenger cars, 1,000 electric tramway cars, and 10,000 switches and signals with electrical motive power. The chief engineer, not yet appointed, is to have £5,000 a year, and his five assistants will have £1,500 per annum. There will be eight locomotive workshop foremen, four carriage shop foremen, and four signal shop foremen, each with salaries ranging from £1,250 to £500."

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**The Niclausse Water-Tube Boiler.**—This boiler has been already described at some length in our columns, and it will be enough to recall here that it is of the double tube type, viz, its water tubes are fixed at one end only and free to move at their lower closed ends, while there is an internal Field tube for circulation. This boiler has thus some virtues not possessed by other boilers. We think the author of the paper read at the B.A. meeting last Friday was badly advised in comparing his boiler with the Belleville. This latter boiler has been approved by the Admiralty. Unfortunately the choice of the Admiralty is not associated with success in numerous cases, and a longitudinal section of a Belleville boiler does not reassure us. To compare another boiler with the Belleville does not say much for the other boiler, and we have a better opinion of the Niclausse boiler than to have used the Belleville as a datum of comparison. The removal of the tubes of the Niclausse boiler is done entirely from the front, the tubes being fixed by coned surfaces, the tightness of which is still a marvel to the English makers of the boiler, *i.e.*, to the author, though why it should be it is difficult to understand.

In the discussion which followed the reading of Mr. Mark Robinson's paper, one speaker asked whether any difficulty had been found in practice from the incrustation of the very small tubes. Incrustation was a very important matter in water-tube boilers. Another speaker asked whether the author could give an idea of the saving in ground space by adopting the Niclausse type in generating stations as compared with the Babcock boilers for the equivalent of power. Also, had Mr. Robinson at present at his works drawings showing the dimensions and form of the furnaces he would use for purposes where space was not of so much importance. What was the best system of baffling the heating gases generated, as they passed up through the heating tubes, so as to get the maximum effect of the heating surface?

Sir Frederick Bramwell contributed a few general remarks on water-tube boilers, and referred to the extremely admirable mode by which the tubes in the Niclausse boiler could be got at, one being easily taken out and another put in its place. He was always sorry to see economisers applied to boilers.

Prof. Hudson Beare had had Babcock boilers running at Edinburgh for two years. In regard to incrustation, he had had a boiler running constantly for two years for electric lighting work, and at the end of the time he withdrew some of the tubes and incrustation could hardly be detected. He referred to the fact that water-tube boilers are now being tried for locomotive work on the South-Western Railway.

Sir W. H. White, the sectional president, said there was another special point in the boiler beside the outer end of the tube, viz., the freeness of the inner. No doubt as regards tendency to bending that was a very great advantage. He had known cases where tubes had bent and the outer had come into contact with the inner, interfering with circulation. That, he thought, was the only serious allegation he had heard against the boiler. The amount of its seriousness was open to question. Looking at what had been done in France, that country had led the way in the modern application of the water-tube boiler. The French were boilering ships on three systems, and they had made about an equal allocation of orders for the various types of tube boilers. Mr. Robinson's point about the rapid withdrawal of tubes and making good defects was a matter of high importance in two ways. With most types, if anything went wrong in the tube the boiler had to be given up until the defective piece was found and made good. Obviously, if they could have a boiler which could be rapidly put back into order and the tubes changed, they could then afford without undue risk to have larger individual power in the boilers, and that must favour economy in weight in relation to power. The fact that the *Seagull* trials with the Niclausse boiler had been delayed so long was due to a series of almost accidental occurrences. The matter had had to stand back because of other things requiring the Admiralty's attention. The consumption of coal per I.H P. per hour was not conclusive, unless you had the efficiency of the engines. He saw in the newspaper that the *Seagull's* first trial had given 2 lbs. per I H P. per hour on a trial with the Babcock of 1·6 lbs. It would be far better if they had the two efficiencies given of the boiler and the engine.

Mr. Robinson, in a brief reply, said that in regard to incrustation there had been the usual experience with water-tube boilers. One recognised that a water-tube boiler required its own treatment. Incrustation gave very little trouble as a rule. It was purely a question of treatment. One used a water-tube boiler because it gave something different to what was obtained with the Lancashire boiler. By far the majority, or, at any rate, a large proportion of the electric lighting stations, now went in for water-tube boilers, so that their advantages were beginning to be recognised. As to baffling, you could put in baffles to taste almost. Regarding the bending of tubes, this was mainly a question of good circulation.

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**The Specific Heat of Water.**—In continuation of a preliminary paper read by them at the Toronto meeting of the British Association in 1897, Prof. Hugh Callendar, of University College, London, and Mr. H. J. Barnes, of McGill College, Montreal, have described to the Physical Section of the Association at the Dover meeting the results of their experiments on the change with temperature of the specific heat of water. The method employed by them is to observe on a differential platinum thermometer the rise in the temperature of a small steady stream of water flowing through a tube and heated in its course by a wire carrying an electric current. In this experiment the capacities for heat of the different parts of the apparatus need not be determined, since the temperatures at all points remain continuously constant, and all the heat developed is carried away in the water. This removes one of the most difficult and uncertain parts of the work of Joule and others. The mode of heating the water as it flows through the tube by an electrical conductor carrying a current enables a large quantity of heat to be developed continuously in a small mass of water, and gives a considerable rise of temperature; while the amount of heat is easily and accurately measured. The differential platinum thermometer indicates, we are told, differences of one ten-thousandth of a degree, and is accurate within one-thousandth of a degree. The flow of heat through the walls of the tube is reduced to a very small amount by the use of vacuum and water jackets. A comparison of the details of this experiment with that of Joule shows in a striking way the advance of laboratory methods due to the establishment of the electrical standards, the potentiometer, and the platinum thermometer. The numerical result arrived at is as follows:—$s_t = S_{40}\{1 + 0{\cdot}0000045 (t - 40)^2\}$ where $s_t$ $s_{40}$ are the specific heats at $t°$ C. and 40° C. respectively; this holds for temperatures between 10° C. and 60° C. The determination corresponds very closely with the results of other good measurements, and the paper discusses at considerable length the probable mode of exactly reconciling them.

**Plymouth Electricity Works.**—The official inauguration of the electricity works and the inauguration of the electric tramways, which have been already described in the Electrical Review, take place to-day, Friday.

The official inspection of the Plymouth Corporation electric system was held on Tuesday, the 19th inst., by Mr. A. P. Trotter, M.A., electrical inspector to the Board of Trade. Mr. Trotter made a very careful and minute examination of the whole route from Theatre Royal to Princes Rock. He inspected the overhead construction, the details of the cars and motors, and the electrical arrangement at the generating station. At various points along the route trials were made of the brakes, both hand and electric. The inspector travelled on the car in both directions, both inside and outside. He was accompanied by Mr. J. H. Ellis (the town clerk), Alderman W. Bray (chairman of the Tramways Committee), and Mr. C. R. Everson (tramway manager); also Mr. J. H. Rider (borough electrical engineer) and Mr. W. A. Tester (resident engineer for the contractors for the line, who travelled on the platform with the inspector and drove the car). The inspector expressed himself extremely pleased and satisfied with everything he had seen, highly complimenting the borough electrical engineer on the first-class equipment of both the tramways and the lighting arrangement, and promised that the official permission to open the line should follow without delay. Continuous running for the general public is to take place immediately after the ceremony to-day.

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**The Copper Market.**—According to Messrs. H. R. Merton and Co.'s mid-monthly circular, the stocks of copper on the 15th inst. were equal to 31,527 tons, as compared with 32,713 tons on August 15th, and 32,389 tons on August 31st. The fall since the latter date has therefore been = 862 tons. The shipments to European ports during the first half of the month have totalled 9,984 tons, while the deliveries have reached 10,846 tons. Of this latter total 1,326 tons is, however, accounted for by *shipments from Liverpool and Swansea to U.S.A.*, and had this buying on American account not occurred, stocks on this side would have risen and prices have fallen. It would be natural to assume that the agents of the New York Syndicate had been "operating" on this side, with a view to keeping up prices, were it not for the fact that during the first half of September the shipments of copper from North America to Europe were quite up to the average, having equalled 5,039 tons. To buy 1,326 tons copper on this side—for re-shipment to New York—while allowing 5,039 tons to come into the European market, is hardly good business for any but those Atlantic steamboat companies who carry the copper. The price of G.M.Bs. on September 15th was £77 per ton, as compared with £76 on August 15th, and £76 15s. on August 31st. The relative costs of copper and aluminium, when used for conducting purposes, are now expressed by—

$$\frac{8{\cdot}93 \times 8{\cdot}65 \times 59}{2{\cdot}68 \times 14{\cdot}5 \times 100} = \frac{4,557}{4,886} = \frac{117}{100}.$$

Copper, therefore, at present prices is considerably dearer than aluminium at 29 cents per lb.

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**Veritys, Limited.**—Messrs. Veritys, Limited, announce a rather important departure in their business. In view of the rapid growth of electrical business in the North of England and Ireland and the present prosperous outlook, they have opened a central establishment at Hardman Street, Deansgate, Manchester, with a well-organised management. Manchester has been selected for headquarters on account of its convenient situation and good business centre. The new premises are said to be well adapted for the wholesale electrical business, containing five floors of 2,600 square feet each. Mr. M. B. Cotterell, who first joined the firm in 1887, and has for some time past held the position of assistant general manager at the works, will be responsible for the management. Mr. A. A. King, who has long been associated with the north county business, remains chief outside representative. The departments into which the business is divided are as follows:—Plant and machinery; wires, cables, bells, telephones, medical apparatus, &c.; switchboards and accessories; electric light fittings.

**Accident at the Manchester Electricity Works.**—The *Manchester Guardian* gives the following account of a somewhat serious accident which occurred at the electricity supply works of that town on Tuesday night. The accident led to injury to two members of the station staff, and a complete failure of the supply for the evening:—"The accident had apparently had its beginning in the breaking of a belt in the engine room. This room contains 15 steam engines, of an aggregate horse-power of 8,100, which are used in the generation of the current. It was the belt of one of these engines that broke, and the sudden throwing off of the load from the engine caused it to 'run away,' with the result that the fly-wheel was broken. The pieces that were sent flying from this wheel broke another fly-wheel. Two of the engines, together of 800 H.P., were thus disabled. Some portions of the fly-wheels also broke one or more of the steam and water pipes. These pipes, like the bulk of the plant at the station, are in duplicate, and the damage done to them would, in ordinary circumstances, have resulted in nothing more serious than a brief interruption of the supply of light; but the damage done to the engines was so great, that the steam and water had to be shut off from the whole range of steam and water pipes, and the work of the station was thus brought to a stand. Beyond the damage which has been described, and the smashing of a number of windows by pieces of the fly-wheels, and by the rush of steam, the building and its contents, as far as could be discovered in the darkness, were not injured to any extent. The engine driver, a man named Edward Tomlinson, was knocked down, and sustained a considerable number of bruises, and the greaser, named Chadwick, was injured about the arms. Chadwick was sent home. Tomlinson was taken to the Royal Infirmary, where it was found that his condition was not such as to cause any alarm. He was, however, detained as an in-patient. Mr. C. H. Wordingham, the chief electrical engineer to the Corporation, who had gone home, was telephoned for, and under his supervision the work of repairing the damage was at once entered upon, and it was hoped that it might be completed by midnight or by the small hours of the morning. Meanwhile, as has been stated, serious loss and inconvenience have been caused in many quarters by the stoppage of current for lighting and motive purposes. From this point of view the accident happened at the worst possible time, as Tuesday is market day in the city, and at six o'clock at night many of the shops are still very busy." No doubt in due course we shall have a true version of the affair from Mr. Wordingham.

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**Personal.**—Mr. Lewis J. Steele, chief electrician to Messrs. Veritys, Limited, has returned to England after a lengthy visit to the United States, where he has visited most of the important electrical centres.

The Chatham Town Council has appointed Mr. H. R. Redman, teacher of magnetism and electricity to the technical education classes.

Mr. H. B. Knowles, M.A., physics and electrical engineering master at the Bradford Technical College, has been appointed (out of five candidates) principal of the Swindon and North Wiltshire Technical School.

Mr. A. Brooker, joint author of the well-known work "Electrical Engineering," by Slingo and Brooker, has resigned his position on the engineering staff of the General Post Office, after 22 years service in its various departments. Mr. Brooker has now joined the staff of the General Electric Company, Limited, and will proceed to Manchester, where he will act as manager of the company's bell and telephone department. We have known Mr. Brooker for many years, and we congratulate the General Electric Company on having secured the services of a gentleman of such proved ability. We feel sure that the appointment will prove mutually satisfactory to both parties, and we shall expect to see very shortly that the manufacture of their telephonic apparatus will favourably compare, both in finish and price, with anything in the market.

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**Marriage.**—On Wednesday, 20th inst., the marriage of Mr. J. R. Garner (electrical engineer of the Clayton Engineering and Electrical Construction Company, Limited, Clayton, Manchester) with Alice, only daughter of Mr. James Whitehead, was solemnized.

**The Postmaster-General's Report.**—The annual report of the Postmaster-General, which has recently been issued, states that as regards the telegraph department the number of telegrams of all descriptions forwarded during the year was 87,043,652, an increase over the previous year of 4,013,653, or 4·83 per cent. The ordinary inland telegrams, which increased in 1897 98 by as many as 3,248,969 over the previous year, show an equally large advance in 1898-99 over the total of 1897-98. The average value of the telegrams slightly declined from 7·43d. to 7 38d. Inland Press telegrams increased in number less rapidly than ordinary telegrams, but their length is indicated by the fact that the average weekly number of words so sent was 14,400,900. On the occasion of the final match at the Crystal Palace for the Football Association cup 3,509 Press telegrams were despatched, containing nearly 42,000 words. The number of foreign telegrams dealt with during the year was the highest on record, and exceeded by 7 59 per cent. the previous year's total.

The concessions made in 1897 in regard to the delivery of telegrams and guarantees for new telegraph offices have contributed in no small degree to the general increase of traffic. . . . .

The communication between coastguard and lifeboat stations around the coast for life-saving purposes has been further extended during the year. Alarm bells were fixed at various post offices for facilitating night calls, and about 43 new stations were added to the system. On the recommendation of the Royal Commission on Electric Communication with Lighthouses, &c., 10 additional shore lighthouses were connected with the postal telegraphic system, and at several of these arrangements have been made by the Board of Trade for the exhibition of storm-warning telegrams from the Meteorological Office. Two outlying lighthouses were also electrically connected with the mainland, but further development of arrangements for telegraphic communication with light-vessels has been deferred pending the question of the adoption of an ætheric system of telegraphy.

The number of post offices open for trunk telephone business on March 31st last was 286, an increase of 22 in the year. . . . . During the year the trunk system was extended to 22 towns, the extension in 16 cases being carried out under guarantee from the National Telephone Company. The total number of trunk wire transactions during the year was 7,066,069, or, reckoning each transaction as involving at least two spoken messages, a total number of 14,132,138 messages (an increase of 19·7 per cent. over the preceding year). The revenue was £167,505 (an increase of 25 per cent.), and the average value of each transaction was 5·68d., as against 5·45d. for the previous year. The reduction in the charges for Post Office telephone exchange wires and for short lines of private wire, which was made in October, 1897, has continued to lead to an increased demand for these facilities, the revenue for the year from this source being £142,600, against £130,100 in the previous year.

The telegraph revenue of the year, £3,260,145, shows an increase of £188,422, and the telegraph expenditure, £3,477,949, an increase of £99,108 upon the previous year.

The postal revenue of the year, including the value of services rendered to other departments, has been £13,049,317, an increase of £628,941 on that of the previous year. The postal expenditure has been £9,194,437, an increase of £511,120 on that of the previous year. Setting expenditure against revenue, the combined accounts show a profit of £3,637,076 on the year, or, if allowance be made for interest on the capital—£10,868,663—created for the purchase of the telegraphs, a profit of £3,338,188.

The number of postal packets delivered in the United Kingdom during the year is estimated as follows:—Letters, 2,186,800,000; post-cards, 382,200,000; book packets and circulars, 701,500,000; newspapers, 154,100,000; parcels (actual number), 71,913,000; total, 3,496,513,000. The rapid growth of telegraph money order business noted in last year's report had continued, the figures for 1898-99 being 25 per cent. in advance of those for 1897-98.

On March 31st last the total number of post offices open was 21,569, and the number of letter boxes was increased during the year to 31,441. The staff of the Post Office was increased during the year by 9,832—from 150,110 to 159,942 persons, of whom 127,779 were males and 32,163 females.

**Death of M. Scheurer-Kestner.**—In the death of M. Scheurer-Kestner France has lost one of her foremost scientific engineers. Like many other notable Frenchmen, Scheurer-Kestner was an Alsatian by birth, but always remained loyal to France, whose recent attitude to men of Alsatian birth has done so much to weaken any lingering remains of French feeling in younger generations in that former province. On the unpopular side in the recent deplorable events, Scheurer-Kestner has had much to worry him, and it is probable that the typhoid fever, which ended with his death, found a subject more or less prepared for its onslaught. He was well known for his researches, and was the author of a treatise on the calorific value of fuels, which is counted as one of the foremost of its kind. His death took place on the 18th inst.

**Calcium Carbide.**—A plant for the manufacture of calcium carbide, employed at Meran, in Austria, is driven by water-power. The turbines drive five three-phase alternators of 1,200 horse-power. According to some figures given by M. Carl Hering in *L'Eclairage Electrique*, and abstracted in the *Engineer*, theoretically it requires 1,900 lbs. of lime, and 1,230 lbs. of carbon to produce a ton of the carbide; in practice, however, 2,050 lbs. and 1,420 lbs. respectively are required. The cost of a ton of lime at this factory is about 16s., and of the carbon about 32s. One electrode will be sufficient for 10 tons of the carbide, and it costs £6 12s., or about 13s. per ton. The electrical energy per ton of the carbide is 6,400 horse-power-hours, which at £2 per electrical horse-power-year is equal to a little over £1 16s. per ton. The accessory machinery, the loss in the lines, &c., corresponds to about 200 horse-power, or about 4s. per ton, the production being about 6·5 tons per day. Labour, at 3s. to 3s. 4d. per day, amounts to about 15s. per ton. Amortisation amounts to about £1 per ton, and the general expenses to about £1 per ton; the maintenance of the plant is given at 6s. per ton. The total cost at the factory is £7 5s. per ton.

**Fire.**—The premises of the Incandescent Electric Lamp Company, Brook Green, Hammersmith, were attacked by fire the other day through the overheating of a boiler. Not much damage was done.

**Electro-Harmonic Society.**—Mr. C. E. Grove, the present honorary secretary of the above society, informs us that the first concert for the new season will be held on Friday next, 29th inst., at the International Hall, Café Monico, Regent Street.

**Reduction of Telegraph Rates to India.**—We have frequently pointed out that in view of the 4s. 9d. rate charged to Australia, a rate of 4s. per word to India was out of all reasonable proportion. We have been told that the low rate to Australia was charged owing to subsidies paid to the companies by the Australasian Colonies. These subsidies are on the point of lapsing, and we now read the following in the Australian Press:—"Details of the sliding scale of charges proposed by the Eastern Extension Cable Company as part of the scheme for constructing an all-British cable *vid* Cape Colony and Glenelg give an early and definite promise of a uniform 2s. 6d. rate throughout Australia, without any cost to the Government."

**University of Glasgow.**—Lord Kelvin's Successor.—The following is a list of candidates who have sent in applications for the Chair of Natural Philosophy now vacant in the University. It is expected that the appointment will be made by the Court early in October:—

J. C. Beattie, D.Sc., F.R.S.E., Professor of Applied Mathematics and Physics, South African College, Cape Town.
Andrew Gray, LL.D., F.R.S., Professor of Physics, University College, North Wales.
Cargill Gilston Knott, D.Sc., F.R.S.E., F.G.S.E., Lecturer in Applied Mathematics, University of Edinburgh.
J. A. M'Clelland, M.A., Demonstrator, Cavendish Laboratory, Cambridge.
G. F. C. Searle, M.A., Demonstrator, Cavendish Laboratory, Cambridge.
John Sealy Townsend, M.A., Clerk Maxwell Student, Trinity, College, Cambridge.
George W. Walker, A.R.C.Sc., B.A., Scholar of Trinity College, Cambridge.
C. T. R. Wilson, B.Sc., M.A., Demonstrator, Cavendish Laboratory, Cambridge.

**The Late Mr. Frank King.**—At their board meeting on 20th inst., the first meeting since the death of Mr. Frank King, their late managing engineer, the directors of the Chelsea Electricity Supply Company passed a resolution expressing their keen sense of loss and their sympathy with his widow and family.

**Appointment Vacant.**—The Corporation of Newcastle-on-Tyne wants a resident electrical engineer to act under a chief engineer in the construction of the electric tramways. Salary £500 per annum. See "Official Notices" this week.

**A New Cable Project.**—The Central News telegraphs from New York to the effect that advices received at Victoria, Vancouver, from Japan, state that at the approaching Session of the Japanese Diet consideration will be given for a concession to a proposed cable from Victoria to the Philippines, *via* Japan. The promoters, who are sanguine of success, undertake to reduce by half the present cable rates to the Far East.

## NEW COMPANIES REGISTERED.

**Scottish Wireless Electric Syndicate, Limited** (4,354).—This company was registered at Edinburgh on September 14th, with a capital of £3,000 in £1 shares, to manufacture and deal in scientific instruments, electric, automatic, and mechanical apparatus, machines and models, &c. The first subscribers (each with one share) are:—Arthur Govan, 15, Benfield Street, Glasgow, merchant; John Trotter, 28, Gordon Street, Glasgow, optician; Walter Jamieson, Orangefield, Greenock, science master; Archibald Barr, 250, Byres Road, Glasgow, engineer; A. B. Scott, 53, Bothwell Street, Glasgow, chartered accountant; James Glen, 139, St. Vincent Street, Glasgow, insurance manager; and James Haldane, 39, Cavendish Street, manufacturer. Table "A" mainly applies. Registered office, 53, Bothwell Street, Glasgow.

**Edwards Electrical Company, Limited** (63,567).—This company was registered on September 13th, with a capital of £10,000 in £1 shares, to take over as a going concern the business of Nathaniel P. Edwards (formerly Nalder & Hilton, Limited), carried on at Trafalgar Works, Bowcommon Lane, E., and to carry on the business of electrical and general engineers, manufacturers of and dealers in electrical apparatus and appliances, bicycle manufacturers, makers of cycle parts and accessories, hardwaremen, manufacturers of mathematical and scientific instruments, &c. The first subscribers (each with one share) are:—Nathaniel G. Edwards, 70, High Holborn, W.C., electrical engineer; John W. Edwards, 70, High Holborn, W.C., ironmonger; Julius Paschek, 44, Wellington Road, Charlton, S.E., electrical engineer; Arthur E. Darville, 5, Gilbey Road, Tooting, S.E., secretary; James Sykes, Suffolk House, Laurence Pountney Hill, E.C., solicitor; Frederick Brown, 43, Farrant Avenue, Noel Park, N., clerk; Edmund Coste, 2, Whitehall Place, Gravesend, gentleman. The number of directors is not to be less than three nor more than five; the first are John W. Edwards and Julius Paschek; remuneration as fixed by the company.

**Electrical Maintenance and Accessories Syndicate, Limited** (63,559).—This company was registered on September 11th, with a capital of £10,000 in £1 shares, to adopt an agreement with George Smith, and to carry on the business of electrical and general engineers, and manufacturers and dealers in cables, wire, accumulators, meters, generators, and all electric, magnetic, telegraphic, telephonic, and other appliances and apparatus, and to construct, repair and maintain any electric lighting, electric supply and other works. The first subscribers (each with one share) are:—E. Chevalier, 70, Derby Street, Hulme, Manchester, cashier; F. Rowbotham, 168, Hulton Street, Salford, manager; A. Seaton, 127, Ellesmere Street, Patricroft, manager; C. E. Longshaw, 435, Chester Road, Old Trafford, Manchester, manager; W. Huffey, Guywood Cottage, Romiley, Chester, manager; F. Hurst, 12, Peel Street, Eccles, Lancashire, printer; and G. Hardcastle, 117, West Park Street, Salford, printer. The number of directors is not to be less than three nor more than five; the first are George Smith (managing director with £300 per annum and a share in the profits) and others to be appointed by the subscribers; qualification, £50; remuneration of ordinary directors as fixed by the company. Registered office, 35, Bridge Street, Manchester.

**Burmah Electric Works Syndicate, Limited** (63,563).—This company was registered on September 12th, with a capital of £2,000 in £1 shares, to acquire any concessions, rights, and privileges in Burmah, and to carry on in Mandalay and elsewhere the business of electric and other tramway proprietors, electricians, producers and suppliers of electric power, &c. The first subscribers are:—E. H. Kindersley, Clyffe, Dorchester, J.P. (2 shares); M. F. Kindersley, Clyffe Cottage, Dorchester, gentleman (100 shares); E. R. Kindersley, Clyffe, Dorchester, gentleman (100 shares); H. R. Kindersley, 19, Ashley Place, London, barrister (100 shares); Miss K. Kindersley, Clyffe, Dorchester (1 share); A. F. Hendly, Clyffe, Dorchester, servant (1 share); and F. B. Fisher, West Walks, Dorchester, surgeon (2 shares). The number of directors is not to be less than three nor more than five; the first are M. F. Kindersley, H. R. Kindersley, and E. R. Kindersley; qualification, £100.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Electrical Power Storage Company, Limited** (30,313).—This company's annual return was filed on August 11th, when 66 founders' and 18,592 ordinary shares were taken up out of a capital of £100,500 in 100 founders' and 20,000 ordinary shares, all of £5 each; £5 per share has been called up on 66 founders' and £3 per share on 3,132 ordinary; £10,200 5s. 1d. has been paid, including £474 5s. 1d. on 409 forfeited shares.

## CITY NOTES.

**Halifax Corporation Electricity Accounts. Public Lighting, Private Supply, and Tramways.**

The accounts of the Halifax Corporation electricity undertaking are interesting owing to the inclusion therein for the first time of the supply of electrical power to the tramway system recently converted to electricity. The figures show a much more satisfactory state of things than the previous year, and no doubt when Mr. H. F. Street, the Borough Electrical Engineer, has completed the re-arrangement of the boiler house, the cost of production will be proportionately reduced. We understand that the same is anticipated regarding oil, waste, and engine room stores, &c., which, by present results, promise to be at least 50 per cent. less during the current year.

The present tariff is 5d. per unit for lighting, and 2½d. for other purposes, subject to a discount varying from 5 to 15 per cent., while the power supply to the tramways is charged at 2d. per unit. Motive power and other purposes apparently only brought in from private consumers a little over £30, and judging by the results of the past few years' working, there seems to be every reason to believe that the department would have done better to have adopted a differential scale of charges on the so-called rebate or Brighton system some time ago. The receipts were as follows for sale of current:—

| | | |
|---|---|---|
| Public lighting ... ... | £840 | |
| Private supply ... ... | 5,538 | (including arrears.) |
| Tramway supply ... ... | 2,332 | (279,867 units) |
| | £8,710 | |

Upon the public lighting a discount of 15 per cent. is allowed, and the average discount upon the private supply is estimated at 6 per cent.

The general state and progress of the undertaking is shown by the following statement:—

| | 1897. | 1898. | Increase. |
|---|---|---|---|
| Total capital expenditure ... ... | £56,322 | £72,470 | £16,148 |
| Number of units sold ... ... | 239,814 | 628,759 | 388,945 |
| Number of lamps connected ... ... | 20,800 | 32,020 | 11,220 |
| Gross revenue ... ... ... ... | £4,846 | £8,957 | £4,111 |
| Gross profit ... ... ... ... | £1,829 | £4,566 | £2,737 |
| Average price per unit sold ... ... | 4·62d. | 3·33d. | −1·29d. |

From this table it will be seen that the gross revenue from all sources has increased by £4,111, and that the gross profit, after paying engineering and management costs, has risen by £2,737. The following statement shows how the revenue is made up, and indicates that notwithstanding the large gross increases, the revenue per unit has suffered on each item; the receipts per unit for sale of current has fallen by a little over 1½d., and the total receipts per unit by a sum just over 1½d.:—

REVENUE STATEMENT.

| | 1897. Gross. | 1897. Per unit. | 1898. Gross. | 1898. Per unit. | Increase. |
|---|---|---|---|---|---|
| Sale of current .. .. | £4,667 | 4·62d. | £8,691 | 3·33d. | −1·29d. |
| Arrears .. | 12 | | 19 | | |
| Meter rents .. .. | 175 | ·18d | 222 | ·08d. | −·10d. |
| Supply of fittings .. | 40 | ·04d | ... | ... | −·04d. |
| Sundry .. .. | 112 | ·11d. | 25 | ·01d. | −·10d. |
| Gross revenue .. .. | £4,946 | 4·95d. | £8,957 | 3·42d. | −1·53d. |

The costs of production show decreases, with the exception of the item of repairs, which has slightly increased. The most important saving occurs on wages, as might be expected, but the reduction of nearly one-third of a penny on coal, already low, is a matter upon which Mr. Street may be congratulated. Nearly one-half of the oil, waste, and engine room stores' item is attributable to water for condensing purposes. Mr. T. P. Wilmshurst was engineer for about half the period under review, and upon his appointment to the engineership at Derby Mr. H. F. Street was promoted to the vacant post, and has the gratification of seeing satisfactory accounts issued at the end of his first six months' running. The details of the "costs" are set out as follows.—

### Costs of Production.

| | 1897. Gross. | Per unit. | 1898. Gross. | Per unit. | Increase. |
|---|---|---|---|---|---|
| Coal | £837 | ·84d. | £1,449 | ·55d. | −·29d. |
| Oil, waste, water, and engine room stores. | 306 | ·30d. | 507 | ·20d. | −·10d. |
| Salaries and wages incurred in generation and distribution. | 829 | ·83d. | 961 | ·37d. | −·46d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 74 | ·08d. | 247 | ·09d. | +·01d. |
| Works' cost | £2,046 | 2·05d. | £3,164 | 1·21d. | −·84d |
| Rent, rates, and taxes | 350 | ·35d. | 358 | ·14d. | −·21d. |
| Management expenses, salaries of managing engineer, secretary, clerks, &c. | 258 | ·26d. | 367 | ·14d. | −·12d. |
| General establishment charges, stationery and printing, law charges and insurance. | 183 | ·18d. | 343 | ·13d. | −·05d. |
| Other expenses | 180 | ·18d. | 159 | ·06d. | −·12d. |
| Total costs | £3,017 | 3·02d. | £4,391 | 1·68d. | −1·34d. |

### Profit Statement.

| | 1897. | 1898. |
|---|---|---|
| Interest on loans | £1,325 | £1,893 |
| Sinking fund for repayments | 1,364 | 810 |
| Net profit deficiency transferred to rates | − 842 | ... |
| „ carried to credit of general rate | ... | 1,862 |
| Gross profit | £1,829 | £4,565 |

Net loss on working, 1897 ... ... ... £842.
Net profit on working, 1898 ... ... ... £1,862.

## Willans & Robinson, Limited.

The half-yearly report, to be submitted at the meeting to be held at the Victoria Works, Rugby, on Wednesday, October 4th, says that after writing off as depreciation from plant, patents, &c., the sum of £4,842 12s. 1d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £3,706 4s. 1d. brought forward) is £26,538 0s. 6d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and at 10 per cent. per annum upon the ordinary shares, together amounting to £12,223 17s. The amount payable to the original directors, in accordance with the articles of association, is £3,870 1s. 0d., leaving a balance of £10,444 2s. 6d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £3,500 to the reserve fund, leaving a balance of £4,944 2s. 6d. to be carried forward. The issue of new capital authorised by the last general meeting has been duly effected. The *pro rata* allotments were generally taken up by the shareholders, and the small balance of shares which remained unallotted were applied for many times over.

**The Direct Spanish Telegraph Company, Limited.**—The board has decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1899, and payable on October 2nd next.

**Rockhampton Gas and Coke Company.**—The directors' report to June 30th, 1899 (half-year), shows that the electrical operations have been carried on at a loss of £105 14s. 10d., but exceptionally large amounts have been debited to maintenance. The expenses were £1,058 14s. 11d., and the revenue £953 0s. 1d.

**Evered & Co., Limited.**—The directors have declared an interim dividend for the half-year ended June 30th, 1899, at the rate of 7½ per cent. per annum, warrants payable on and after September 30th. The transfer books are closed till October 2nd.

**Edmundson's Electricity Corporation.**—The whole of the shares issued a few weeks ago (£47,000) have been taken by the present shareholders in the company, who applied for more shares than the issue amounted to.

## TRAFFIC RECEIPTS.

**The Blackpool and Fleetwood Tramroad Company.**—The receipts for the week ending September 16th, 1899, were £1,136 6s. 10d.; receipts for week ending September 16th, 1898, £996 17s. 9d.; aggregate for half-year to date, £16,934 9s. 5d.

**The Bristol Tramways and Carriage Company, Limited.**—The receipts for the week ending September 15th, 1899, were £3,360 10s. 6d.; corresponding period 1898, £3,334 16s. 8d.; increase, £24 6s. 2d.

**The City and South London Railway Company.**—The receipts for the week ending September 17th, 1899, were £868; week ending September 18th, 1898, £900; decrease, £32. Total receipts for half-year, 1899, £11,285; total receipts corresponding period, 1898, £11,386, decrease, £101. Miles open, 5½.

**The Dover Corporation Electric Tramways.**—The receipts for the week ending September 16th, 1899, were £308 1s. 9d.; week ending September 17th, 1898, £240 15s. 11d.; increase, £67 5s. 10d. Total receipts to date, 1899, £7,383 0s. 9d.; corresponding period, 1898, £5,990 17s. 2d.; increase, £1,392. 3s. 7d. Miles of track open, 1899, 3; 1898, 3. Car miles run, 1899, 5,444 1898, 3,848. Number of cars, 1899, 13; 1898, 10.

**The Dublin United Tramways Company.**—The receipts for the week ending Friday, September 15th, 1899, were as follows:—D. U. T. Co., horse cars, £1,160 10s. 7d.; ditto, electric cars, £2,011 0s. 7d.; D. S. D. Co., electric cars, £891 18s. 10d.; total, £4,063 10s.; corresponding week last year—D. U. T. Co., horse cars, £2 464 15s.; ditto, electric cars, £469 16s.; D. S. D. Co., electric cars, £1,012 16s. 2d.; total, £3,947 7s. 2d.; increase, £116 2s. 10d. Aggregate to date, £51,347 5s. 7d.; aggregate to date last year, £49,786 15s. 1d.; increase to date, £1,560 10s. 6d. Worked:—The mileage open is 25 miles electrically, 19 miles by horses, as against 19 miles electrically, and 30 miles by horses, for the corresponding period last year.

**The Halifax Corporation Tramways.**—The receipts for the week ending September 17th, 1899, were £683. Miles of track open, 10. Car miles run, 11,396. Number of cars, 21. The receipts for the week ending September 21st, 1898, were £295. Increase, £388. Miles of track open, 8½. Car miles run, 8,762. Number of cars, 10. Total receipts to date, 1899, from April 1st, 1899, £14,596; total receipts to date, 1898, from June 29th, 1898, £3,433.

**The Liverpool Overhead Railway Company.**—The receipts for the week ending September 17th, 1899, amounted to £1,484; corresponding week last year £1,495; decrease, £11.

**The South Staffordshire Tramways Company.**—The receipts for week ending September 15th, 1899, were £744 8s. 5d. aggregate receipts for 37 weeks, £24,584 19s. 3d.; week ending September 16th, 1898, £642 13s. 2d.; aggregate receipts for 37 weeks, £23,800 10s. 7d.

## STOCKS AND SHARES.

Wednesday Evening.

Dulness is all that can be expected in such unquiet times as those now passing, but the electrical market holds its position with surprising strength considering all things. The general tendency of prices in any department of the Stock Exchange during bargainless days is, however, to sag away, as it were, of their own weight, and this disposition is not absent from the electrical supply shares. The greater part of the business done during the past week has been in the various metropolitan shares. Citys for the most part of their time have been weak, but strength is displayed by Metropolitan Electric Supply Ordinary. The company is taking rank among the "gilt-edged" list. We are inclined to regard "Mets" as one of the best shares to buy in the electrical market, more particularly because there is likely to be a steady advance in the value of the shares. The Charing Cross victory over the City Company has so far been productive of nothing, but we must warn impatient shareholders that the company's new powers require the most careful handling on the part of the directors, and in the present condition of the money market, Stock Exchange opinion is against any attempt to raise the fresh capital that will be required. Not that the company will have any difficulty in getting the cash; a firm of underwriters jauntily told us the other day that they were quite prepared to carry the business through by themselves, on certain terms.

The new Pacific cable should prove a grand chance for some of the telegraph construction companies to make money. The India-Rubber, Gutta-Percha and Telegraph Works Company is likely to get at least part of the contract, and a very good part, too. The present price of the shares is about 21½; the capital is half a million sterling, and there is a debenture issue of £300,000.

The Telegraph Construction Company has also some chance of participation in the new line, and the shares have already begun to move a little. The price is round about 40, but dealings are difficult, and almost a matter of negotiation.

We are afraid, however, that speculation with regard to the new cable is still premature, and it may be a long time before any of the actual work is put in hand.

Electric railway descriptions remain quiet as ever. It is interesting to notice that the Exploration Company—one of the largest holders of Central London shares—is taking a leading part in that electrifying of the Parisian tramway system to which we referred last week. The Exploration Company is one of the Rothschild's creations, and possesses interests all over the world.

Preliminary negotiations are on foot for covering the county of Durham with a network of electric trams. A small syndicate is in course of formation to furnish the capital necessary to meet the initial expenses, and the experiment will be watched with considerable attention. The enterprise of the British Electric Traction Company, and its activity in the Midlands, has been the means of pointing out how great a field exists for this class of business. Provincial tramways shares, however, are inclined to weakness at the moment, the result of the general uneasiness prevailing in the Stock Exchange.

## SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. † | Dividends for the last three years. 1896. | 1897. | 1898. | Closing Quotation, Sept. 13th. | Closing Quotation, Sept. 20th. | Business done during week ended Sept. 20th, 1899. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 124,400£ | African Direct Telegraph, 4 % Debs. ... ... ... | 100 | ... | ... | ... | 100 —104 | 100 —104 | ... | ... |
| 25,000 | Amazon Telegraph, shares ... ... ... ... ... | 10 | ... | ... | ... | 3 — 4 | 3 — 4 | ... | ... |
| 125,000 | Do. do. 5 % Debs., Nos. 1 to 1,250 Red. | 100 | ... | ... | ... | 85 — 90 | 85 — 90 | ... | ... |
| 905,560£ | Anglo-American Telegraph ... ... ... ... ... | Stock | £2 13s | 3 % | £3 9s | 63 — 66 | 63 — 66 | ... | ... |
| 3,047,220£ | Do. do. 6 % Pref. ... ... ... | Stock | £5 6s | 6 % | 6 % | 114½—115½ | 114 —115 | 115⅝ | 114 |
| 3,047,220£ | Do. do. Deferred... ... ... | Stock | ... | ... | 18s. % | 14¼— 14⅜ | 14¼— 14⅜ | 14⅜ | 14 7/16 |
| 205,151 | Brazilian Submarine Telegraph ... ... ... ... | 10 | 7 % | 7 % | ... | 14⅜— 15¼ | 14⅜— 15¼ | 15 | 14⅜ |
| 75,000£ | Do. do. 5 % Debs. 2nd series, 1906 ... | 100 | ... | ... | ... | 107 —111 | 107 —111 | ... | ... |
| 44,000 | Chili Telephone, Nos. 1 to 44,000 ... ... ... ... | 5 | 4 % | 4 % | ... | 2½— 3 | 2½— 3 | ... | ... |
| 10,000,000$ | Commercial Cable ... ... ... ... ... ... | $100 | 8 % | 8 % | 8 % | 188 —193 | 188 —193 | ... | ... |
| 1,332,523£ | Do. do. Sterling 500 year 4 % Deb. Stock Red. | Stock | ... | ... | ... | 104 —106 | 104 —106 | 105 | ... |
| 224,850 | Consolidated Telephone Construction and Manufacturing | 10/- | 2 % | 1½% | 1 % | ¼— ¼ | ¼— ¼ | ... | ... |
| 16,000 | Cuba Telegraph ... ... ... ... ... ... ... | 10 | 8 % | 7 % | 8 % | 9 — 10 | 9 — 10 | 9⅞ | ... |
| 6,000 | Do. 10 % Pref. ... ... ... ... ... | 10 | 10 % | 10 % | 10 % | 18½— 19⅛ | 18½— 19½ | ... | ... |
| 12,931 | Direct Spanish Telegraph ... ... ... ... ... | 5 | 4 % | 4 % | ... | 4 — 5 | 4 — 5 | 4 | ... |
| 6,000 | Do. do. 10 % Cum. Pref. ... ... | 5 | 10 % | 10 % | ... | 9½— 10½ | ⁹ — 10½ | 9⅞ | ... |
| 30,000 | Do. do. 4½ % Debs. ... ... ... | 50 | ... | ... | ... | 103 —107% | 10. —107% | ... | ... |
| 60,710£ | Direct United States Cable ... ... ... ... ... | 20 | 3 % | 3½% | 3½% | 11⅜— 12¼ | 11⅜— 12¼ | 12⅛ | 11⅜ |
| 120,000 | Direct West India Cable, 4½ % Reg. Deb. ... ... | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 4,000,000 | Eastern Telegraph, Ord. Stock ... ... ... ... | Stock | 6½% | 7 % | 7 % | 149 —154 | 145 —150 | 150 | 145½ |
| 1,795,000 | Do. 3½% Pref. Stock ... ... ... | 100 | ... | ... | ... | 99 —102 | 99 —102 | 100⅝ | 99 |
| 89,900 | Do. 5 % Debs., repayable August, 1899 ... | 100 | 5 % | 5 % | ... | ... ... | ... ... | ... | ... |
| 1,432,268£ | Do. 4 % Mort. Deb. Stock Red. ... ... | Stock | 4 % | 4 % | ... | 116 —121 | 117 —122 | 120½ | ... |
| 250,000 | Eastern Extension, Australasia, and China Telegraph ... | 10 | 7 % | 7 % | 7 % | 14½— 14⅝ | 14½— 14⅝ | 14⅝ | 14½ |
| 16,200£ | Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 | 100 | 5 % | 5 % | ... | 99 —103 | 99 —103 | ... | ... |
| 64,400£ | Do. do. Bearer, 1,050—3,975, 4,327—6,400 | 100 | 5 % | 5 % | ... | 100 —103 | 100 —103 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock ... ... ... ... ... | Stock | 4 % | 4 % | ... | 115 —120 | 116 —121 | ... | ... |
| 85,100£ | Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | ... | ... | 99 —103 | 99 —103 | ... | ... |
| 46,500£ | Do. do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909 | 100 | 4 % | ... | ... | 101 —104 | 101 —104 | ... | ... |
| 200,000£ | Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000 | 25 | 4 % | ... | ... | 102 —105% | 102 —105% | 102 | ... |
| 180,227 | Globe Telegraph and Trust ... ... ... ... | 10 | 4½ % | 4½ % | 5½ % | 10⅜— 11¼ | 10⅜— 11¼ | 10 1/16 | 10⅜ |
| 180,042 | Do. do. 6 % Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 15 — 15½ | 14⅜— 15¼ | 15¼ | 15 |
| 150,000 | Great Northern Telegraph, of Copenhagen... ... ... | 10 | 10 % | 10 % | ... | 30 — 32 | 30 — 32 | ... | ... |
| 89,500 | Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red. | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 17,000 | Indo-European Telegraph ... ... ... ... ... | 25 | 10 % | 10 % | 10 % | 48 — 52 | 48 — 52 | 49 | ... |
| 100,000£ | London Platino-Brazilian Telegraph, 6 % Debs. ... ... | 100 | 6 % | 6 % | ... | 106 —109 | 106 —109 | 107 | ... |
| 71,000 | Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 ... | 1 | ... | ... | ... | ¼— ½ | ¼— ½ | ... | ... |
| 84,000 | Do. do. 5% Pref., Nos. 1 to 84,000 | 1 | ... | ... | ... | ¾— 1 | ¾— 1 | ... | ... |
| 490,000 | National Telephone, 1 to 490,000 ... ... ... ... | 5 | 5½% | 6 % | 6 % | 5⅜— 5⅝ | 5⅜— 5⅝ | 5 5/16 | 5 1/16 |
| 15,000 | Do. 6 % Cum. 1st Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | 13⅞ | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | 13 | ... |
| 250,000 | Do. 5 % Non-cum. 3rd Pref., 1 to 250,000 | 5 | 5 % | 5 % | 5 % | 5¼— 5⅜ | 5¼— 5⅜ | 5⅜ | ... |
| 1,329,471£ | Do. 3½ % Deb. Stock Red. ... ... | Stock | 3½% | 3½% | 3½% | 99 —102 | 99 —102 | 100¾ | 100¼ |
| 171,504 | Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid | 1 | 5 % | 5 % | 5 % | ¾— 1 | ¾— 1 | ... | ... |
| 100,000£ | Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ... | 100 | 4 % | 4 % | ... | 103 —106 | 103 —106 | ... | ... |
| 11,839 | Reuter's ... ... ... ... ... ... ... ... | 8 | 5 % | 5 % | ... | 7 — 8 | 7 — 8 | ... | ... |
| 3,381 | Submarine Cables Trust ... ... ... ... ... | Cert. | ... | ... | ... | 130 —135 | 130 —135 | ... | ... |
| 58,000 | United River Plate Telephone ... ... ... ... | 5 | 5 % | 6 % | ... | 4⅜— 5¼ | 4⅜— 5¼ | 4⅜ | ... |
| 151,783£ | Do. do. 5 % Debs. ... ... ... | Stock | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 200,000£ | West African Telegraph, 5 % Debs. ... ... ... ... | 100 | 5 % | 5 % | ... | 99 —102 | 99 —102 | 103 | ... |
| 30,008 | West Coast of America, Nos. 1—30,000 and 53,001—53,008 | 2½ | ... | ... | ... | ½— 1 | ½— 1 | ... | ... |
| 150,000 | Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel. | 100 | ... | ... | ... | 101 —104 | 101 —104 | ... | ... |
| 889,521 | Western and Brazilian Telegraph 4 % Deb. Stock Red. ... | Stock | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 88,321 | West India and Panama Telegraph ... ... ... ... | 10 | 1 % | 1% | ... | 1⅜— 1⅝ | 1½— 1½ | ... | ... |
| 84,563 | Do. do. do. 6 % Cum. 1st Pref. ... | 10 | 6 % | 6 % | ... | 10½— 10⅝ | 10½— 10⅝ | ... | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. ... | 10 | 6 % | 6 % | ... | 8¾— 9⅛ | 8¾— 9⅛ | ... | ... |
| 80,000£ | Do. do. do. 5 % Debs., Nos. 1 to 1,800 | 100 | 5 % | 5 % | ... | 104 —107 | 104 —107 | ... | ... |
| 158,100£ | Western Union of U.S. Telegraph, 6 % Ster. Bonds ... | 100 | 6 % | 6 % | ... | 98 —103 | 98 —103 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electricity Supply ... ... | 5 | 6 % | 7 % | 8 % | 10 — 11 | 10 — 11 | 10⅞ | 10⅜ |
| 20,000 | Do. do. do. do. 4½ % Cum. Pref. | 5 | ... | ... | ... | 6 — 6½ | 6 — 6½ | 6¼ | 6 1/16 |
| 34,000 | *Chelsea Electricity Supply, Ord., ... ... ... ... | 5 | 5 % | 6 % | 6 % | 7½— 8½ | 7½— 8½ | ... | ... |
| 100,000 | Do. do. do. % Deb. Stock Red.... | Stock | 4½ % | 4½ % | ... | 113 —115 | 113 —115 | ... | ... |
| 60,000 | City of London Electric Lighting, Ord. 40,001—100,000 ... | 10 | 7 % | 10 % | 6 % | 11½— 12½ | 11 — 12 | 12 | 11½ |
| 40,000 | Do. 6 % Cum. Pref., 1 to 40,000 ... ... ... | 10 | 6 % | 6 % | 6 % | 12½— 13½ | 12½— 13½ | 13¼ | ... |
| 400,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | ... | 125 —130 | 125 —130 | ... | ... |
| 40,000 | County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000 | 10 | nil | nil | nil | 11 — 12 | 11 — 11½ | ... | ... |
| 20,000 | Do. do. do. 6 % Pref., 40,001—60,000 | 10 | 6 % | 6 % | 6 % | 13½— 14½ | 13 — 14 | 13 | ... |
| 220,000 | Do. 4½% Deb. Stock, Prov. Certs (£30% to be paid) Rd. | ... | ... | ... | ... | 82 — 85 | 82 — 85 | 83½ | ... |
| 17,400 | Edmundsons Elec. Corp., Ord. Shares 1—17,400 ... ... | 5 | ... | 5 % | 7 % | 5 — 5½ | 5 — 5½ | ... | ... |
| 19,661 | House-to-House Electric Light Supply, Ord., 101 to 19,661 | 5 | ... | 4 % | 6 % | 8 — 9 | 8 — 9 | ... | ... |
| 12,000 | Do. do. 7 % Cum. Pref. ... | 5 | 7 % | 7 % | ... | 9 — 10 | 9 — 10 | ... | ... |
| 110,000 | London Electric Supply Corporation, Limited, Ord. ... | 3 | ... | ... | ... | 3½— 4 | 3½— 4 | ... | ... |
| 48,050 | Do. do. do. 6 % Pref. | 5 | ... | ... | 6 % | 6½— 7 | 6½— 6⅝ | ... | ... |
| 100,000 | Do. do. do. 4% 1st Mt. Db. Stock Rd. | Stock | ... | ... | ... | 105 —107 | 105 —107 | ... | ... |
| 62,500 | Metropolitan Electric Supply, 101 to 62,500 ... ... | 10 | 5 % | 6 % | 5 % | 14½— 15½ | 14½— 15½ | 15⅛ | 14¾ |
| 22,500 | Do. Nos. 62,501 to 85,000 ... ... ... | 10 | ... | ... | ... | 14 — 15 | 14 — 15 | ... | ... |
| 220,000£ | Do. 4½ % First Mortgage Debenture Stock | ... | 4½% | 4½% | ... | 117 —119 | 117 —119 | ... | ... |
| 6,452 | Notting Hill Electric Lighting ... ... ... ... | 10 | 4 % | 6 % | 6 % | 15 — 16 | 15 — 16 | ... | ... |
| 31,980 | St. James's and Pall Mall Electric Light, Ord. ... ... | 5 | 10½% | 14½% | 14½% | 16½— 17½ | 16 — 17 | 17 | 16⅜ |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 9 — 10 | 9 — 10 | 9½ | ... |
| 65,000 | South London Electricity Supply, Ord., £4 paid ... ... | 5 | ... | ... | ... | 3¾— 4½ | 3⅞— 4½ | 3⅛ | ... |
| 79,900 | Westminster Electric Supply, Ord., 101 to 80,000 ... | 5 | 9 % | 12 % | 12 % | 15 —16 | 15 — 16 | 15½ | 15 1/16 |

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
Divid ds marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1896. | 1897. | 1898. | Closing Quotation Sept. 13th. | Closing Quotation Sept. 20th. | Business done during week ended Sept 20th, 1899. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 60,000 | Aluminium "A" shares, Nos. 1—60,000 ... ... ... | 1 | 10 % | 10 % | ... | 2¾— 3¼ | 2¾— 3¼ | 3 | ... |
| 90,000 | Do. 4½ % 1st Mort. Deb. Stock Red. ... ... | Stock | ... | ... | ... | 97 —102 | 97 —102 | ... | ... |
| 30,000 | British Electric Traction ... ... ... ... ... | 10 | ... | ... | 6 % | 17½— 18½ | 17½— 18½ | 17⅞ | ... |
| 10,000 | Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.) | 10 | ... | ... | ... | 13⅞— 14¼ | 13⅞— 14¼ | 13 15/16 | 13⅞ |
| 20,000 | Do. do. do. Nos. 40,001—60,000 | 10 | ... | ... | ... | ... | ... | ... | ... |
| 200,000 | Do. do. 5 % Perpetual Debenture Stock ... | Stock | ... | ... | ... | 127 —130 | 127 —130 | ... | ... |
| 40,000 | British Insulated Wire Ord., Nos. 1 to 40,000 ... ... | 5 | ... | ... | ... | 11 — 12 | 11 — 12 | ... | ... |
| 27,500 | Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ... | 5 | ... | ... | ... | 6¼— 6⅜ | 6¼— 6⅜ | ... | ... |
| 90,000 | Brush Elecl. Enging., Ord., 1 to 90,000 ... ... ... | 3 | *nil* | 3 % | 5 % | 1⅞— 2⅛ | 1⅞— 2 xd | ... | ... |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 4 % | 6 % | 6 % | 2⅛— 2⅜ | 2⅛— 2⅜ xd | 2 5/16 | 2 1/16 |
| 125,000*l* | Do. do. 4½ % Perp. Deb. Stock ... | Stock | ... | ... | ... | 108 —112 | 110 —114 | 111⅝ | 111½ |
| 50,000 | Do. do. 4½ % 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 101 —104 | 103 —106 | ... | ... |
| 20,000 | Callender's Cable Construction shares, Nos. 1—20,000 ... | 5 | 10 % | 12½ % | 15 % | 13½— 14½ | 13½— 14½ | ... | ... |
| 90,000 | Do. do 4½ % 1st Mort. Deb. Stock Red. | Stock | ... | ... | ... | 112 —115 | 112 —115 | ... | ... |
| 35,250 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 10¼— 10⅜ | 10¼— 10⅜ | 10⅜ | ... |
| 178,303 | Do. do. do. £8 paid ... ... | 10 | ... | ... | ... | .. | ... | ... | ... |
| 61,033 | Do. do. Pref. half-shares ... ... | 5 | ... | ... | ... | 4⅜— 5½ | 4⅜— 5½ | ... | ... |
| 71,447 | Do. do. Def. do. ... ... ... | 5 | ... | ... | ... | 5½— 5⅝ | 5½— 5⅝ | 5 9/16 | ... |
| 630,000*l* | City and South London Railway ... ... ... ... | Stock | 1 9/16 % | 1⅞ % | 2⅛ % | 65 — 67 | 64 — 66 | 65½ | ... |
| 22,500 | Do. do. Ord. shares, Nos. 1 to 22,500 ... | 10 | ... | ... | ... | 6½— 6⅝ | 6½— 6⅝ | ... | ... |
| 32,098 | Crompton & Co., Nos. 1 to 32,098 ... ... ... ... | 3 | ... | ... | ... | 3½— 4 | 3½— 4 | 3⅝ | ... |
| 100,000 | Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red. | ... | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 99,261 | Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261 | 5 | 5⅛ % | 6 % | 6 % | 2 — 2⅛ | 2 — 2⅛ | 2 1/16 | ... |
| 17,139 | Do. do. do. "A" Shares, 01—017,139 | 5 | 5⅛ % | 6 % | 6 % | 4 — 5 | 4 — 5 | 4 7/16 | ... |
| 344,023 | Do. do. do. 4 % Deb. Stock Red. ... | 100 | ... | ... | ... | 95 — 97 | 95 — 97 | ... | ... |
| 112,100 | Electric Construction, 1 to 112,100 ... ... ... ... | 2 | 5 % | 6 % | 6 % | 2⅛— 2⅜ | 2⅛— 2⅜ | 2⅛ | ... |
| 25,000 | Do. do. 7 % Cum. Pref., 1 to 25,000 ... | 2 | 7 % | 7 % | 7 % | 3 — 3⅛ | 3 — 3⅛ | 3⅛ | ... |
| 140,300 | Do. do. 4% Perp. 1st Mort. Deb. Stock ... | Stock | ... | ... | ... | 102 —105 | 103 —106 | 103½ | ... |
| 91,196 | Elmore's Patent Copper Depositing, 1 to 70,000 ... ... | 2 | ... | ... | ... | ⅝— ⅞ | ⅝— ⅞ | ... | ... |
| 9,600*l* | Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ... | 10 | 7 % | 7 % | 7 % | 11 — 13 | 11 — 13 | ... | ... |
| 15,000 | Henley's (W. T.) Telegraph Works, Ord. ... ... ... | 10 | 10 % | 12 % | 14 % | ... | ... | ... | ... |
| 3,000 | Do. do. do. 7 % Pref. ... ... | 10 | 7 % | 7 % | 7 % | ... | ... | ... | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock... | Stock | 4½ % | 4½ % | ... | 110 —113 | 110 —113 | ... | ... |
| 50,000 | India-Rubber, Gutta-Percha and Telegraph Works ... | 10 | 10 % | 10 % | 10 % | 21 — 22 | 21 — 22 | 21½ | 21⅝ |
| 300,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 102 —106 | 102 —106 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 2½ % | 3½ % | 3½ % | 7⅞— 8½ | 8⅛— 8½ | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 13¼— 13⅜ | 13¼— 13⅜ | ... | ... |
| 37,350 | Telegraph Construction and Maintenance ... ... ... | 12 | 15 % | 15 % | 15 % | 37 — 41 | 37 — 41 | 39 | ... |
| 150,000 | Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 . | 100 | ... | ... | ... | 103 —106 | 103 —106 | ... | ... |
| 13,400 | Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ... | 5 | ... | ... | ... | 9¼— 9⅜ | 9¼— 9⅜ | ... | ... |
| 13,400 | Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000 | 5 | ... | ... | ... | 5⅜— 6¼ | 5⅜— 6¼ | ... | ... |
| 540,000*l* | Waterloo and City Railway, Ord. Stock ... ... ... | 100 | ... | ... | 3 % | 101 —104 | 101 —104 | 103½ | ... |

† Quotations on Liverpool Stock Exchange.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

‡ Unless otherwise stated all shares are fully paid.

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8⅛—9⅛.
British Aluminium, Ordinary, 9½—10; 7 % Pref., 10—11.
House-to-House, 4½ % Debentures of £100, 104—107.
National Electric Free Wiring, 10s. paid, 6s.—8s.
Smithfield Market Electric, 2—3.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12½—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7⅛—7⅜. Debentures, 103 —106. Dividend, 1898, on Ordinary Shares 10%.
*T. Parker, £10 (fully paid), 19.

Bank rate of discount 3½ per cent. (July 13th, 1899).

### MARKET QUOTATIONS, Wednesday, September 20th.

| CHEMICALS, &c. | This week. | Last week. | Increase or Decrease. |
|---|---|---|---|
| Acid, Hydrochloric .. .. per cwt. | 5/- | 5/- | .. |
| " Nitric .. .. .. per cwt. | 22/- | 22/- | .. |
| " Oxalic .. .. .. per cwt. | 32/- | 32/- | .. |
| " Sulphuric .. .. .. per cwt. | 5/6 | 5/6 | .. |
| a Ammoniac, Sal .. .. per cwt. | 85/- | 85/- | .. |
| a Ammonia, Muriate (crystal) .. per ton | £25 | £25 | .. |
| a " " .. .. per ton | £23 | £23 | .. |
| a Bleaching powder .. .. per ton | £5 15 | £5 15 | .. |
| a Bisulphide of Carbon .. .. per ton | £15 | £15 | .. |
| a Borax .. .. .. per ton | £16 10 | £16 10 | .. |
| a Benzole (90 %) .. .. .. per gal. | 7/- | 7/- | .. |
| a " (50/90 %) .. .. per gal. | 5/6 | 5/6 | .. |
| a Copper Sulphate .. .. .. per ton | £24 | £24 | .. |
| a Lead, Nitrate .. .. .. per ton | £23 10 | £23 10 | .. |
| a " White Sugar .. .. per ton | £31 | £31 | .. |
| a " Peroxide .. .. .. per ton | £27 10 | £27 10 | .. |
| a Methylated Spirit .. .. per gal. | 2/9 | 2/9 | .. |
| a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal. | 5/6 | 5/6 | .. |
| a Potash, Bichromate, in casks .. per lb. | 9¼d. | 9¼d. | .. |
| a " Caustic (75/80 %) .. per ton | £24 | £24 | .. |
| a " Bisulphate .. .. per ton | £35 | £35 | .. |
| a Shellac .. .. .. .. per cwt. | 68/- | 68/- | .. |
| a Sulphate of Magnesia .. .. per ton | £4 10 | £4 10 | .. |
| a Sulphur, Sublimed Flowers .. per ton | £6 | £6 | .. |
| a " Recovered .. .. per ton | £5 10 | £5 10 | .. |
| a " Lump .. .. .. per ton | £5 | £5 | .. |
| a Soda, Caustic (white 70 %) .. per ton | £7 10 | £7 10 | .. |
| a " Crystals .. .. .. per ton | £3 | £3 | .. |
| a " Bichromate, casks .. per lb. | 2¾d. | 2¾d. | .. |
| **METALS, &c.** | | | |
| Aluminium Wire, in ton lots .. per ton | £294 | £294 | .. |
| b " Sheet, in ton lots .. per ton | £191 | £191 | .. |
| p Babbitt's metal ingots .. .. per ton | £90 to £160 | £90 to £160 | .. |
| c Brass (rolled metal 3" to 12") basis per lb. | 8¾d. | 8¾d. | .. |
| c " Tube (brazed) .. .. per lb. | 10¼d. | 10¼d. | .. |
| c " Wire, basis .. .. per lb. | 8¾d. | 8¾d. | .. |

| METALS, &c. (*continued*). | This week. | Last week. | Inc. r Dec. |
|---|---|---|---|
| f Ebonite Rod .. .. .. per lb. | 3/- | 3/- | .. |
| f " Sheet .. .. .. per lb. | 5/- | 5/- | .. |
| g Copper Bars .. .. .. per ton | £88 | £88 | .. |
| g " Wire (basis price) .. per lb. | 10½d. | 10½d. | .. |
| g " Sheet .. .. .. per ton | £88 | £88 | .. |
| g " Rod .. .. .. per ton | £88 | £88 | .. |
| m German Silver Wire .. .. per lb. | 1/6 | 1/6 | .. |
| h Gutta-percha, fine .. .. per lb. | 6/- | 6/- | .. |
| h India-rubber, Para fine .. per lb. | 4/3 to 4/4 | 4/2 to 4/8½ | 1½d. inc. |
| i Iron, Charcoal Sheets .. .. per ton | £18 | £18 | .. |
| i " Pig (Cleveland warrants) per ton | 67/11½ | 67/4½ to 69/7 | .. |
| i " Forgings, according to size per ton | From £11 | From £11 | .. |
| i " Scrap, heavy .. .. per ton | 50/- to 55/- | 50/- to 55/- | .. |
| i " Wire galvanised No. 8 .. per ton | £14 | £12 17 6 | £1 2 6 inc. |
| g Lead, English Ingot .. .. per ton | £15 5 | £15 5 | .. |
| g " " Sheet .. .. per ton | £15 7 | £15 7 6 | .. |
| m Manganin Wire No. 28 .. .. per lb. | 8/- | 8/- | .. |
| g Mercury .. .. .. per bottle | £8 12 | £8 12 | .. |
| d Mica (in original cases), small per lb. | 2d. to 6d. | 2d. to 6d. | .. |
| d " " " medium per lb. | 1/9 to 2/6 | 1/9 to 2/6 | .. |
| d " " " large per lb. | 3/6 to 7/- | 3/6 to 7/- | .. |
| p Phosphor Bronze, plain castings per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| p " rolled bars & rods per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| p " rl'd strip & sheet per lb. | From 1/2½ | From 1/2½ | .. |
| o Platinum .. .. .. .. per oz. | £3 10 | £3 10 | .. |
| p Silicium Bronze Wire .. .. per lb. | .01d. to 1/1 | 10½d. to 1/1 | .. |
| i Steel, Magnet, acc'd'g to desc'p'n p. ton | to £40 | From £15 | .. |
| i Steel, Magnet, in bars .. .. | £58 | £58 | .. |
| g Tin, block .. .. .. .. per ton | £149 10 | £149 10 | .. |
| g " foil .. .. .. .. per lb. | 1/6 | 1/6 | .. |
| n " wire Nos. 1 to 16 .. .. per lb. | 1/10 | 1/10 | .. |
| p White Anti-friction Metals— | | | |
| "White Ant" brand .. per ton | £40 to £70 | £40 to £70 | .. |
| j Yarns, Cotton, Single 10lb. bundles pr lb | 7½d. | 7½d. | .. |
| j " Best Flax, 6 lea. .. per lb. | 4½d. | 4½d. | .. |
| j " Hemp, 3 ply 10 lbs. .. per lb. | 3½d. | 3½d. | .. |
| j " " Russian, 10 lbs. per lb. | 4½d. | 4½d. | .. |
| j " Jute, 180 lbs. rove .. per ton | £13 | £13 | .. |
| j " Manila, 24 thread .. per ton | £39 10 | £36 10 | £3 inc. |
| k Zinc, Sheet (Vielle Montagne bnd.) p.t. | £27 | £27 | .. |

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakespeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yee & Co.

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n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

## BRITISH ASSOCIATION, DOVER, 1899.

### SIGNALLING WITHOUT CONTACT.

A System of Railway Signalling specially suitable for Fog Signalling.

Paper read before Section G on Monday, September 18th, by Mr. W. S. Boult, Assoc.M.Inst.C.E.

The object of this paper is not to classify and compare the work that has been done in various directions in regard to railway signalling, but rather to deal with the question *de novo* in connection with successful practical work with apparatus described below.

The subject was originally approached by the author from the, in many respects, favourable position of the looker-on—who proverbially sees most of the game, his mind being perfectly open and uninfluenced in any direction by tradition or interest. He had, however, long held the opinion that the existing method of conducting railway signalling, especially during fogs, was far from satisfactory, for several reasons, and was capable of great improvement. It is surely a reflection on the present age, which justly prides itself on the advanced state of scientific knowledge and its application to practical purposes, that in a thick fog the only means of informing a driver of an approaching train that his next signal is against him should be to send out a man to put on the line something that will make a noise when the engine goes over it, and that, if no noise is heard, the driver is to assume that the line is clear, and he may go on—a method of working considered too dangerous to employ in regard to clear weather signals.

Independently of other objections, there is often great difficulty experienced in regard to having the men at their posts when wanted, notwithstanding all that has been done by the railway companies in preparation for emergencies, including the building of large numbers of cottages for the men, and the fitting up of electric call bells. It is not a very long time since an accident occurred directly after the foggers had been withdrawn, owing to a small unnoticed bank of fog and a train arriving together at a signal standing at danger, which, being invisible to the driver, was run past. In the case of fogs of exceptional duration another difficulty comes in owing to the men all being worn out with long hours and exposure to the weather. Fogging also is dangerous work for the men so employed, and has been the cause of numerous injuries and fatalities. Mr. W. M. Acworth, in "The Railways of England," says:—

"A long-continued fog seldom lifts without leaving one or two gaps in the army of platelayers."

As regards the cost of fogging, it is very difficult—probably impossible—to obtain detailed particulars, but the following extracts are not without interest:—

In "The Working and Management of an English Railway," the late Sir George Findlay, then general manager of the London and North-Western Railway, said:—

"There is one element which causes perhaps more difficulty, and entails more anxiety upon those engaged in the management of a railway than all others put together, and that is the prevalence of fogs in this country. . . . . Each man is provided with a hut to shelter him, a fire, and a thick, warm overcoat, which is supplied by the company for his use. As soon as he has been on duty three hours he is supplied with refreshments at the company's expense, and again six hours later, if the fog continues so long; and after 12 hours, if the fog still continues, he goes off duty, and his place is taken by a relief man. . . . . Inquiries have shown that during the week in question" (in January, 1888) "on the London and North-Western Railway alone, fogmen had to be provided at 2,462 signal posts; 2,375 men were employed, in addition to 1,377 relief men, making a total of 3,752 men."

It is only fair to add that Sir George writes in the highest praise of the results attained.

In "The Railways of England" Mr. W. M. Acworth says:—

"The men receive extra pay in addition to their ordinary wages, and are supplied with meals by the company as well. In a single one of the ten districts into which the North-Western is divided the food alone sometimes costs £100 in a single winter's month. The great fog of January, 1888, caused to a comparatively small company like the Sheffield a bill of £1,350, including as one item 360 gross of fog-signals. I have a return from a second-class station near London showing for that station alone an extra expenditure of over £80 per annum. . . . . It has been long felt by railway men that the present primitive system by which a man simply stands beside the distant signal, and if the arm goes up fastens a detonator on the line—or, rather, for greater precaution, two detonators, in case one should miss fire—and if the arm goes down, hastily pulls it off again, is a system that stands in need of radical reformation."

If further evidence is wanted as to the importance of the subject and the general desire for improvement, it may be found in the following letter received by the author from Mr. Francis Hopwood, secretary to the Board of Trade (Railway Department):—

"Board of Trade (Railway Department),
"7, Whitehall Gardens, London, S.W.,
"May 4th, 1896.

"Sir,—I am directed by the Board of Trade to advert to your letter of 27th ult. on the subject of your invention of an improvement in fog signalling, and in reply to the observations and request contained therein, to state that the Board would be glad to see some improvement in the present system of fog signalling, and to point out that the matter has, on occasion, been dealt with by the railway inspecting officers of this Department in their reports on certain railway accidents.

"I am further to observe that, if a mechanical system of this nature, perfect and reliable in all respects, can be found, the Board see no reason why it should not supersede the existing system.

"I am, Sir, your obedient Servant,
"(Signed) Francis J. S. Hopwood."

At the engineering conference last June the author introduced the subject of fog signalling, and in reference to this Sir Douglas Fox, chairman of the "Railways" section, remarked that the matter called loudly for reform, and that the general adoption of mechanical appliances would decrease the loss of life occurring with the methods now in use.

In *Fielden's Magazine* for August, Sir W. H Preece, K.C.B., President of the Institution of Civil Engineers, speaks of "the present barbarous, dangerous and irregular system of fog signalling."

As, owing to the interchange of traffic on the various companies' lines, any system of signalling, to be of extended practical utility, would have to be approved by railway engineers and managers in general, it appears highly advisable that the requirements to be demanded from any such system should be authoritatively discussed and settled, so that inventors and experimenters may have definite data to work upon.

In the hope of raising such a discussion the author has formulated these requirements as they present themselves to him, and submits the following as a comprehensive list:—

1. Certain action.
2. Simple construction.
3. Slow deterioration.
4. Good protection from accidental damage.
5. Easy replacement of damaged or worn out parts.
6. Minimum amount of cleaning and overhauling.
7. Moderate first cost.
8. Moderate maintenance and working expenses.
9. Signals must be given in the cab of the engine and in any vehicle fitted with receiving apparatus.
10. Action must be independent of speed or even movement of engine, and applicable as a starting signal.
11. Apparatus must work when engine is run either end first.
12. Two distinctive signals must be given—for "danger" and "line clear," respectively.
13. Distant and home signals must be clearly differentiated.
14. The signals must be capable of re-delivery at intervals as arranged.
15. Repeating in signal-box must be provided for.
16. A clearing signal should be given from the tail vehicle to the signal-box to show that the whole train has passed, and on which line, if more than one each way.
17. Commencing failure of action must be at once indicated while correct signals are being given.
18. It must be impossible for an engine-driver to mistake another signal for his own.
19. Failure of apparatus on the road must give the danger signal on the engine.
20. It must be impossible for the engine-driver by tardiness in stopping a bell, working a signal replacer, or otherwise, to prevent the receipt of a succeeding signal.
21. The whole apparatus must be unaffected by fog, frost, snow, rain, hail, wind, or changes of temperature.
22. Means must be provided for indicating which of several branch roads is made.
23. Each signalman should be able to veto "line clear" given by the signalman in advance.
24. The system must admit of "lock and block" and automatic block working.

Let us now more carefully consider these requirements and what they entail.

1. *Certainty of Action.*—The necessity of as near an approach to absolute certainty as may be attained by fallible humanity and apparatus need not be contended for. The best way of attaining this result is, first, by the utmost possible simplification and protection of apparatus—especially moving parts—and, second, by independent duplication of fundamental parts, as practised now in the case of detonators.

2. *Simplicity.*—As just pointed out, this conduces to reliability; it also has an important bearing on first cost and maintenance expenses. It is evident that complicated or delicate apparatus would be quite out of place for constant work on a locomotive.

3. *Slow Deterioration.*—This is important as affecting both reliability and cost of maintenance. It is absolutely necessary that there shall be no chance of anything working out of adjustment, bending, breaking, wearing away, or otherwise giving out, without ample notice through infrequent periodical examination.

4. *Good Protection.*—All parts of apparatus should be securely boxed in, or so strong as not to be liable to injury by accidental knocks from falling objects, &c.

5. *Quick Replacement of Worn or Damaged Parts by New Ones.*—This obviously is most important, not only as affecting the cost of repairs, but preventing the possibility of causing delays to traffic.

6. *Minimum Cleaning, &c.*—In view of the large number of apparatus that would be required, this is of great importance as seriously affecting maintenance expenses. To this end it is most desirable that all moving parts whatever that would be in any way liable to clogging or injury by dirt or weather should be *completely* boxed in.

7. *Moderate First Cost.*—This is chiefly important in view of the number of apparatus required. It is, however, not of such consequence as

8. *Moderate Maintenance and Working Expenses.*—Seeing that thick fogs occur only on a few days out of the 365, it is evident that to be successful fog-signal apparatus must require very little attention to keep it in operative condition.

9. *Signal to be Given on Engine.*—The object of signals being to convey information to the engine driver, it certainly seems that the natural and best place in which to exhibit visible signals is right in front of the driver's face; audible signals also are to be received in the cab of the engine, and naturally should be given there. The best form of signal is a point requiring discussion; probably, at all events for danger signals, a miniature semaphore or equivalent signal and continuous action electric bell form the best combination, the bell continuing to ring so long as the signal remains on, or until the driver's attention is attracted. Many locomotive engineers do not view with favour the idea of applying to their engines apparatus which they deem to be dangerously fragile and liable to damage. It is for the designers of such apparatus to treat with all respect views founded on practical experience of locomotive working such as the majority of such designers do not possess, and to spare no pains to render their apparatus simple, strong, and well protected. There is another consideration often urged against giving signals on the locomotive, viz:—that all locomotives using any line worked by such signals must be fitted with receiving apparatus.

This difficulty is purely one of agreement amongst the various railway companies, and should be capable of settlement whenever any one system has proved itself thoroughly fitted for its work, and superior to all competitors. When once this state has been reached, and a system universally adopted, it will be just as much a matter of course to fit an engine with receiving apparatus as it is now to apply a safety valve or brake apparatus. The unnecessary loss of money incurred in fitting up rolling stock to suit two or even three systems of continuous brakes, should be taken as a warning not again to deal piecemeal with a subject better made a Clearing House matter.

10. *Action unaffected by Speed.*—This is clearly necessary, as not only may a signal have to be given to an engine travelling at any speed, but it should be possible by the same system to start an engine that has been stopped.

11. *Reverse Direction of Movement.*—Tank engines at least must be able to take signals when running either end first, and all engines must be able to pass up or down a line without doing damage. If any special movement has to be made to compensate for reversed running, this can probably be done by an attachment to the reversing lever.

12. *Distinctive Danger and Line-clear Signals.*—This, of course, would be a great improvement upon the present method of giving danger signals only, and greatly help the driver in determining his position, besides doing away with the necessity for treating no-signal as line-clear.

13. *Distant and Home Signals.*—Here, again, the driver will be assisted in determining his position.

14. *Re-delivery of Signal.*—By this means the driver may be as well informed as by seeing a semaphore from a distance. Requirements 12, 13, and 14 together ensure as great facility in signalling in fogs as is obtained by semaphores in clear weather.

15. *Repeating.*—It is obviously necessary that the signalman shall know definitely that he *has* set his apparatus as intended.

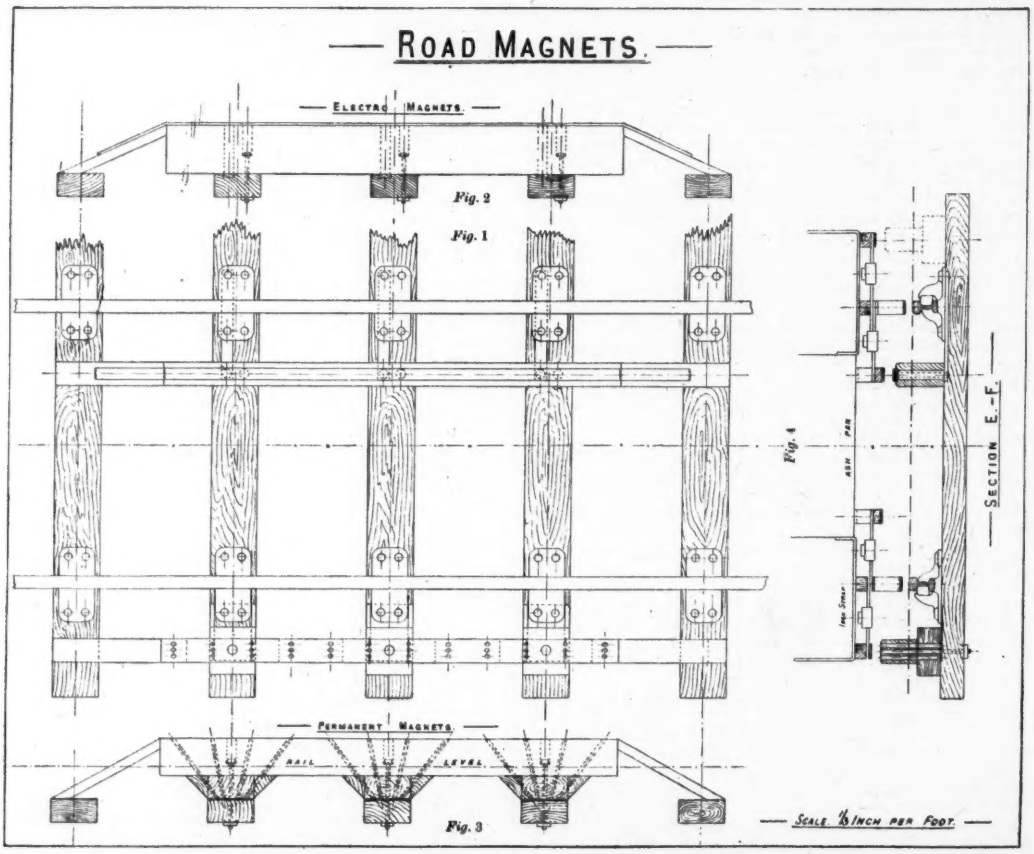
16. *Clearing Signal.*—This signal is especially wanted in thick fogs, when the tail lights of a train are visible only within a very short range, and it may not be easy for the signalman to see on which line a train is running.

17. *Commencing Failure Indicated.*—The best method of meeting this requirement is probably by independent duplication of fundamental parts and separate indication of their action. It may also be met by complete duplication of receiving apparatus. In either case the chance of two failures at the same instant is so remote, as to be negligible.

18. *Mistaking Signals.*—Any signal given in the cab of the engine prevents all possibility of a signal meant for one engine being acted on by another. This is another argument in favour of signalling on the engine, as emphasised by the collision at Crewe on October 4th, 1897, when four goods trains were wrecked in consequence of an engine driver acting on another man's signal.

19. *Failure on Road must Give Danger Signal on Engine.*—This is insisted on in the case of semaphores, which are weighted so as to take the danger position if a connection breaks; and surely it is doubly needful in foggy weather, though not attained with the present system.

20. *Late Replacing of Signal.*—Interference with a following signal by late replacement may be guarded against in different ways, but, at least in the case of danger signals, it is clear that it must be absolutely guarded against.




21. *Weather.*—It is, of course, a *sine quâ non* that the apparatus shall work equally well, and without special adjustment, at all possible temperatures and in all weathers.

22. *Route Indication.*—It is highly desirable that the engine driver should know that he is about to be sent on to the line he wants; but as the worst result of a mistake would be loss of time, this is essential only from a business point of view. Without such information it would be necessary, wherever there was a possibility of being turned on to the wrong road, not to go faster than would be safe on the worst road that could be given.

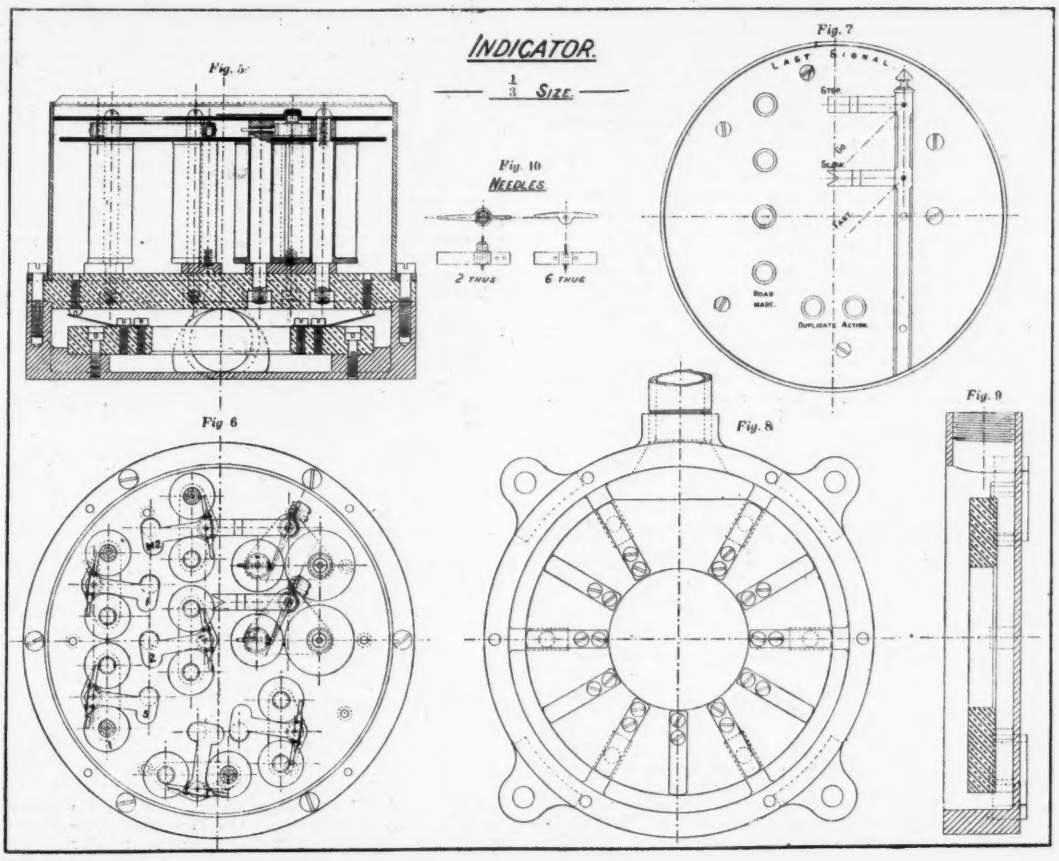
23. *Veto.*—This is the quickest way of stopping a train in which anything wrong was noticed as it passed.

24. *Block Working.*—The advantages of "lock and block" working are now generally admitted. For "light railways" and other purposes it is probable that automatic block working might be advantageously adopted.

Assuming the sufficiency of the above numerous and exacting requirements, the question comes:—How are they to be met? In answering this question, the first and all-important point is to find some medium or vehicle whereby some influence or movement may be conveyed from the stationary road to even the fastest running engine with practical certainty of action in all cases.

Apparatus actuated by mechanical contact between something on

the road and something on the moving engine could, it is at once evident, never be satisfactory or inspire confidence, however often it worked all right; for blows given at a speed of 120 feet per second—the actual speed occasionally attained by some express trains—could not fail to quickly find out and develop any incipient flaws, however well proportioned, balanced, and aligned the apparatus might be. Moreover, wear of rails, tyres, and contact pieces, would necessitate perpetual overhauling and adjusting on both road and engines. Further, it is much to be desired that there should be no movement into and out of contact position of anything on the road, as all such movable parts would involve the expense of constant cleaning, oiling, and overhauling, even if required in actual use on only a small number of days in the whole year. Their action also must depend upon the proper compensation or adjustment of the already overloaded distant signal wire just at the time when the semaphore is invisible, so that *all* such moving parts would have to be repeated in the signal box. These objections apply more or less to all apparatus for placing detonators on the rails, many forms of which have been proposed, though at best only a danger signal is thus given, and the magazines have to be looked after and kept supplied with detonators which are used up at all sorts of varying rates—always supposing the machine remains in working order.




Another plan, adopted by numerous inventors, is the employment of electricity as the medium of communication with the engine, and at first sight this seems to offer great advantages. On consideration, however, many objections appear. Bare, insulated, and necessarily unprotected, conductors, must be laid on the road, and contact made therewith by a brush or contact piece on the engine. This, of course, may be in the form of a wire brush, or a plate spring, or be otherwise made more or less elastic, so as to reduce shocks, but, for all that, at high speeds, shocks there must be, as well as *wear* and *bending*, these last always tending towards want of alignment, so that, sooner or later, missed contacts between badly worn brushes and roadway conductors would be certain to occur, even if nothing got carried away. Dirt, snow and frost, would also be likely to prevent metallic contact. Again, with bare contact bars, the current might in various accidental ways be short circuited or cut off. But the fatal objection to purely electrical systems is, that failure of current in the roadway conductors or of contact therewith results simply in giving no signal, which, of course, might easily lead to most serious disaster. The author is aware that it has been proposed to guard against this contingency by causing the brush-holder, when the brush is raised by contact with the roadway conductor, to act as a switch to close a local circuit through a battery on the engine so as to show a fault signal if this is not held off by the main current. This, however, involves the use of two systems—electric contact and mechanical movement—and necessarily increases shocks, wear, and liability to damage; and, if failure of the main circuit is due to the brush having been carried away, or to its clearing the contact bar owing to banding or wear, is no safeguard whatever, as the cause of failure affects both circuits alike.

Sight, hearing, mechanical movement, and electric contacts, judged by the standard of requirements given, all fail to do all that is wanted. Appealing to the sense of smell also is, for obvious reasons, out of the question. There remains one means of transmission not yet mentioned, that is, magnetism, and consideration shows that magnetism is thoroughly well suited to the purpose in view. There are three ways in which magnetism can be employed to work across an air gap, such as is desired between the stationary and travelling parts, viz: (1) by direct pull on the travelling armature, mechanically transmitted thereby; (2) by inducing a current in a conductor on the moving vehicle; and (3) by actuating a pivoted needle or spring tongue, which may be incorporated with a rigidly held armature on the vehicle to be signalled.

The first two methods have previously been proposed, but clearly cannot do all that is wanted. No. 1 would need impossibly large magnets (at all events, except where dynamo currents were available), would actuate mechanism with great suddenness, and would give only one signal for each armature and set of magnets, and No. 2 would simply not work on a standing or slowly moving vehicle, and at best, like No. 1, would give only one signal. The third method, however, which appears never before to have been suggested, possesses none of these drawbacks.

Arriving at this conclusion in the manner above set forth, the author turned his attention to devising suitable magnetic apparatus, with results which he now has the honour to submit for criticism.

In brief outline his system consists in placing on the road magnets so arranged as to establish a long magnetic field of transverse polarity, and carrying on the engine through this field an iron armature, not itself to be moved by attraction to the magnets, but containing in a dividing gap or space therein a small pivoted needle on which magnetism collected by the armature is condensed or focussed so as to strongly act upon it and throw it over to one side. The polarity of the field from the road magnets is arranged to be from right to left, or left to right as required; and, as the direction in which the needle in the moving armature is thrown over depends upon the polarity of the magnetism collected by the armature, it is evident that the combination forms a simple means of determining the movement of the needle. The needle when thrown in one direction comes against an insulated contact post and thus closes one electric circuit on the engine, and when thrown in the opposite direction, similarly closes another circuit. When away from the influence of road magnets, it is magnetically, or otherwise, held in the middle of its travel, and clear of both contact posts. The action is that of the well-known polarised relay, the road-magnets and armature taking the place of the electro-magnets in the instrument used in telegraphy.

With the means of closing either of two independent local circuits

(on the engine) thus provided, practically any signals preferred can be given and if desired recorded.

After the usual experiments, consideration, and alterations, incidental to the designing of new machines, the author's apparatus has now assumed the form shown in the drawings herewith.

### Road Magnets.

The road magnets are by preference placed as shown in figs. 1 to 4. Permanent magnets, arranged in fan-shaped groups on iron plates over the sleeper ends, are placed in holes bored through a longitudinal timber, as shown in figs. 1, 3 and 4. The iron plates pass under the contiguous chairs, thus completing an iron connection to the upper surface of the rail, close to which travels a collecting pole plate on the engine armature. A similar pole plate on the other side of the armature passes just above the upper ends of the magnets. As will be seen from fig. 4, with the exception of the desired clearance between stationary and travelling parts, a complete iron circuit is provided for the magnetic flux.

On the inside of the other rail are shown three electro-magnets very similarly arranged, but with their upper ends connected to a common pole plate. In practice the permanent and electro-magnets would not be on the same sleepers, but, as explained below, it is proposed to have the permanent magnets in duplicate—one set to each rail.

### Indicator.

Figs. 5 to 10 are views showing the construction of the indicator for complete signalling. The various indications are all given in the same way by a movement which may be explained in relation to the home semaphore. This semaphore is carried by a tongue or armature pivoted on a magnet and playing between the cores of two coils after the manner of a polarised relay; the cores and magnet all standing on a common iron base. The magnetic action, however, is not that of the telegraph relay, only one coil being energised to produce movement. For instance, if the semaphore, which is shown on, is to be thrown off, the right-hand coil will be energised with N. polarity at its outer end (the outer end of the magnet and tongue being S.), the effect being to strengthen the magnet, and, therefore, the tongue, and to reverse the polarity of the left-hand core, which then repels the tongue at the same time that the right-hand core is attracting it. Owing to the facts that the left-hand core is not too strongly magnetised, and that the magnetism of the tongue is simultaneously strengthened, seizing is prevented, and the tongue may be thrown through a large angle.

Fig. 7 shows the dial of the indicator, with home and distant semaphores, duplicate action spots, and four number holes for indicating the road made at junctions. Figs. 5, 8 and 9 show the permanently wired base of the instrument, with radiating contact springs for connecting up the indicator coils.

*(To be continued.)*

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## SOME RECENT APPLICATIONS OF ELECTRO-METALLURGY TO MECHANICAL ENGINEERING.

By Sherard Cowper-Coles, Assoc.M Inst.C.E., M.I.M.E., M.I.E.E.

*(Read in Section G, September 18th.)*

### Abstract of Contents.

The paper commences by pointing out the prominent position electro-metallurgy is now taking in many workshops, and enumerates the uses to which electro-metallurgy is being applied. It then proceeds to give a description of an electro-galvanising plant for coating the tubes of water-tube boilers and the plates of torpedo boat destroyers, and also gives details of the anode and cathode bars for suspending the electrodes, and information as to the thickness of zinc applied, and the current density and voltage employed. Estimates are given as to the cost and output of various sized plants, and the advantages of electro-galvanising over hot galvanising are compared. The regenerative or recuperative process and methods of circulation are also described. Particulars are then given of various electro-chemical processes for cleaning iron and removing magnetic oxide and scale, and a description is given of a magnetic scale collector for collecting the scale from the acid solution after its removal from the iron or steel, so as to prevent the further unnecessary waste of acid. Experiments made in this direction tend to show that a considerable proportion of the acid is consumed by dissolving the scale after it has left the iron or steel.

An electrolytic process for the manufacture of reflectors is then described, suitable for making parabolic reflectors for search lights. The various steps of the process are given in detail. Briefly, the process consists in using a glass convex mould, on which is chemically deposited a coating of metallic silver, and then polished, so as to ensure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame, and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120° F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two.

The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent it tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness.

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Electro-chemistry and metallurgy are beginning to play an important part in large engineering works; for instance, electricity is now being applied to galvanising, the removal of mill scale, the production of metallic reflectors, the manufacture of copper tubes and sheets, the recovery of tin from tin scrap, and for the coating of iron and steel with brass, for welding, brazing, soldering, and for sharpening files. It is also being introduced to allied industries, such as the manufacture of white lead. Time will not permit of my giving a description of more than the three first applications.

*Galvanising.*—Electro-galvanising is at the present time extensively used for coating the frames and plates of torpedo boat destroyers and for the galvanising of tubes for water-tube boilers, such as the Normand.

One feature that makes this process particularly suitable for this class of work is, that it does not cover up defects, nor does it reduce the tensile strength of iron and steel of small section, or distort it, as in the case of hot galvanising, but it shows up any defect in the steel, which means a considerable saving of time and money, as any flaw in the steel is detected at an early stage of manufacture, and not in the final testing, as, for instance, when all the parts of a boiler have been assembled. Another advantage of electro-galvanising is that the plant can be worked intermittently without loss, and varying thicknesses of zinc can be obtained at the will of the operator; the thickness of zinc usually applied to such work as boiler tubes is ¾ oz. to 1¼ ozs. per square foot.

The process of electro-galvanising consists of first removing the scale and rust from the work to be galvanised, either by immersing in an acid solution or by sand blasting. It is then placed direct in the galvanising bath, which is composed of a solution of zinc sulphate containing about 30 ozs. to the gallon of solution. The work to be galvanised is suspended by means of gun-metal carriers which rest on bars or girders running the length of the tank; the electric current is conducted into the solution by means of lead or zinc plates, the voltage at the terminals of the dynamo being six, the number of amperes per square foot of cathode surface 15 to 20.

The solution is rapidly circulated through the bath by means of a small centrifugal pump or air compressor, and is regenerated as the zinc is deposited by passing it over a filter bed composed of carbon, coke, or sand, mixed with zinc dust, which is obtained as a by-product during the distillation of zinc from its ores.

Figs. 1 and 2 illustrate a plant suitable for coating plates up to 7 feet in length, and is also applicable for coating tubes, such as those

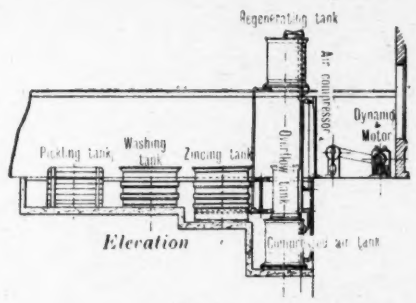



Fig. 1.

of the "Belleville" water-tube boilers. The plan and elevation both show the regenerating tanks and circulating arrangements. The regenerated electrolyte enters at the bottom of the zincing tank, the liquid which is returned to the regenerators being drawn off from the

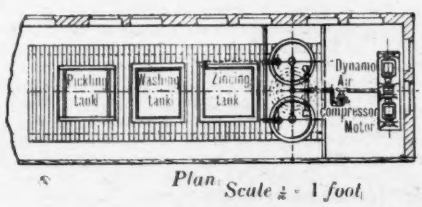
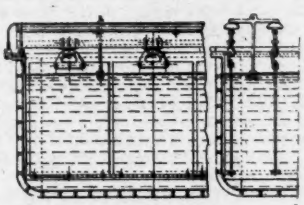



Fig. 2.

top of the solution over a wood sill placed in the corner of the zincing vat. Fig. 3 shows the carriers and compound anode and cathode bars which are used for carrying the anodes and cathodes. On the table are a number of specimens of electro-galvanised tubes, &c., also some interesting specimens of sheets which have been electro-galvanised under a pressure of about 1 ton to the inch.

*Removal of Mill Scale.*—The removal of mill scale is a matter of considerable moment with many large engineering firms. The ordinary pickling process is tedious and costly, and electricity is now being used to hasten the process. The removal of oxide and scale from forgings and plates has always been a matter of difficulty, the scale in many cases being over $\frac{1}{32}$th inch in thickness and very adherent. The usual practice is to place the iron in a solution containing one

part of hydrochloric or sulphuric acid to 10 parts of water, for a period varying from half-an-hour to 24 hours—half-an-hour for close annealed sheets, 24 hours for plates and forgings, such as are employed for ship and bridge building.



Figs. 3 and 4.

Many experiments have been made to quicken the process and to reduce the cost. One of the first experiments was to make the iron to be pickled the anode in an acid bath, but this was found to pit the plates, as the iron which was not protected by the mill scale was more readily dissolved than that covered by the magnetic oxide. To overcome this difficulty, the current was reversed every few minutes, the iron being alternately made anode and cathode.

A device for catching the scale after it is removed from the iron so as to prevent the further unnecessary consumption of acid by dissolving the mill scale and oxide after removal, has been tried with satisfactory results. The pickling solution is circulated by means of a small pump or an externally heated lead coil, through a lead-lined box or chamber, behind which are placed electro-magnets as the solution flows past the poles of the magnets, the magnetic oxide in suspension is attracted and retained, and can be removed from time to time.

In America, another electrical pickling process has been tried, the solution being sulphate of soda or sulphuric acid. The plates to be cleansed from the negative electrode, and an iron plate the positive electrode; the hydrogen set free from the surface of the plate removes any grease that may be present, and reduces any oxides on the surface.

A voltaic method is said to do the work with more certainty and with less danger to the surface of the metal in the way of pitting. The articles to be cleansed are used as the positive pole of the battery, the negative pole being either carbon or wire gauze, electroplated with silver, and covered with amorphous platinum black. The bath consists of dilute sulphuric acid, containing a depolariser, such as nitric or chromic acid; the use of the latter agent, it is claimed, completely prevents the evolution of offensive gases.

Another process, which also depends on the use of electro-magnets, being a modification of the one I have already described, consists of an apparatus containing an electro-magnet encased in copper.

The scale collector (fig. 4) is placed in any convenient position in the tank, and connected by means of terminals to a depositing or electric lighting dynamo, the current required to work it being about 10 amperes when an E.M.F. of 6 volts is employed.

Fig. 5.

In the case of large pickling tanks two or more scale collectors can be employed, or only one may be used, this being moved about to different parts of the bath at suitable intervals. From time to time the scale collector is taken out, and the adhering scale removed, either by breaking the circuit or by means of a suitable brush or scraper.

On the table is a model of the apparatus, also a photo of the collector after it has been dipped in iron filings. It will be noticed that the electro-magnet has consequent poles, this method of connecting up having been adopted with the object of distributing the field as much as possible.

*An Electrolytic Process for the Manufacture of Projectors.*—Projectors are now extensively used for naval and military operations, every man-of-war, torpedo boat destroyer and fort being supplied with one or more, as the power of rendering visible distant objects is of great value.

During the American war with Spain, searchlights played a most important part in the blockade of the Cuban coast. The most essential part of the projector consists of optical means whereby the rays of some source of light are collected by reflection or refraction, or both, and projected in the form of a parallel beam towards the distant object which it is desired to illuminate. If the light emanated from a point, exactly the focus of a perfect parabolic mirror, the beam would be rendered absolutely parallel. In the case of the arc, however, the light comes from the crater of the positive carbon, which is of appreciable size, especially with large currents. Every point of the mirror is, therefore, struck with a cone of light, the angle of the cone depending on the size of the crater and the focal distance, consequently the whole beam after reflection disperses at the same angle. Light collected by a surface is inversely proportional to the square of the distance of the source of light, but after a certain limit has been reached, the amount of light received by the mirror does not continue to increase as the solid angle, on account of the obscuration effected by the walls of the crater. This obscuration begins to tell after a section of the solid angle has been reached of about 65°. The source of light of the point of a 1-foot mirror of 1-foot focus, would be as good as that of a 2-foot mirror with a 2-foot focus, both taking the same solid angle of light. The dispersion of a Manger mirror burning a 30 mm. positive carbon with 150 amperes is about 2°, that of a Schuckert is about the same, though the focal distance is less, the light collecting power is therefore greater.

Glass mirrors at the present time have been exclusively used for projectors for search lights and similar purposes. One advantage of a parabolic metal reflector is that the rays from the carbon points are collected into parallel beams by means of reflection only, and is not catadioptric, as most glass mirrors are. A perfect parabolic mirror, of exact mathematical curvature, ensures parabolism of the rays, especially if the source of illumination is of very small dimensions.

Great difficulties have been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light, and the influences of damp air and sea water. Spun reflectors are never true, as it is found in practice impossible to spin them quite true to the moulds. Experiments have been made with a view to substituting cast metal for glass, but the cost of grinding and polishing, and the unsatisfactory surface that is obtained, have resulted in the attempts being abandoned. Stamped reflectors have also been tried, but with no more satisfactory results.

The process now about to be described is electrolytic, one of the chief features being that the surface produced requires no after polishing or trueing up. When once a true mould has been produced, any number of reflectors can be taken from it at a small cost.

A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. As the mould only requires shaping and polishing on the convex side, it is comparatively cheap, as compared to a glass reflector, which has to be ground on both sides.

The glass moulds are prepared as follows:—First of all, a convex cast-iron mould is made to the approximate curve of the mirror. From this a concave mould is made of refractory material. Over this is laid a piece of flat glass about ⅜-inch thick, the whole being placed in a furnace and heated to such a temperature that the glass will adapt itself to the curvature of the mould without fusing. The roughly-shaped glass mould thus prepared, is then ground and polished on the convex side only. The mould is revolved slowly, the first breaking down operation being done by means of emery wheels, the desired curvature being given to the mechanical feed by means of a template or gearing. The glass is finally polished with pads and rouge, which are caused to move over the surface in different directions. This process is a very expensive and laborious one, two to three months being taken for the largest sized reflectors. The next step in the process, after having obtained a suitable glass mould, is to clean it, and then coat the convex surface with a coating of metallic silver, which is thrown down chemically on the glass and polished so as to ensure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame, which is described later on, and immersed in an electrolyte of copper sulphate, the mould being revolved in a horizontal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120° F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent it tarnishing. Palladium is found to answer this purpose; a bright coating can be deposited rapidly to any desired thickness. Palladium resists tarnishing and the heat of an arc to an extraordinary degree. Palladium is a silver-white metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is 11·4, being about half that of platinum. The present price of palladium is about double that of platinum, but its weight being only one-half, the same area can be covered at the same cost. At the present time there is very little use for palladium, which accounts for its comparatively high price. The following table gives the comparative hardness of palladium as compared to other metals:—

| | |
|---|---|
| Nickel electro-deposited ... ... ... ... ... | 10·0 |
| Sheffield plate ... ... ... ... ... | 10·0 |
| Antimony electro-deposited ... ... ... ... | 9·0 |
| Platinum deposited bright ... ... ... ... | 9·0 |
| Palladium deposited bright ... ... ... ... | 8·0 |

| | |
|---|---|
| Chromium electro-deposited on copper ... ... ... | 7·0 |
| Cadmium deposited bright ... ... ... ... | 4·5 |
| Silver electro-deposited and burnished ... ... ... | 4·0 |
| Silver (deposited chemically) ... ... ... ... | 2·0 |

The figures give the hardness as represented by the number of centigrammes weight on a diamond point required to produce a scratch. In carrying out the manufacture of reflectors by this process, it is essential that the glass mould should be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that if the cleaning is solely effected by chemical means, there is a great liability of the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleansing the mould with a suitable paste or powder, such as peroxide of iron, and then washing the glass in a 50 per cent. solution of ammonia. It is necessary that this cleansing operation be repeated prior to the production of each mirror. After the convex side of the mould has been properly cleaned, a thin coating of metallic silver is applied as follows, the process being that commonly employed for silvering reflectors for astronomical telescopes:—Two solutions are prepared, the first of which contains the silver salt; the second, the sugar preparation. Ammonia is added to a solution of nitrate of silver until the precipitate that is formed is dissolved, then re-precipitating with caustic soda again dissolving in ammonia; a solution of glucose is then added. Excellent results have been obtained with a silvering solution made up of equal parts of solution of the following strengths:—Silver nitrate 0·55 per cent., caustic potash 0·25 per cent. The author has found the weight of silver deposited from such a solution to be equal to about ·000588 per square inch, the thickness being ·0000034 inch.

The surface of the mould to be coated is immediately dipped into the solution face downwards. In from four to five minutes the silver begins to form on the glass mould, the solution changing from pink to dark brown and black; the film thickens quickly, and in from 30 to 35 minutes a good coating of silver is deposited. Dr. Common has found a good deposit of silver to be equal to a thickness of $\frac{1}{28000}$ inch. The silver is found to be clearer, thicker, and more uniform, if the glass mould is dipped into a proto-chloride solution of tin, and then washed before being placed in the silvering bath; the action is supposed to be catalytic. The silver coating is thoroughly washed and then allowed to dry, and the silver which has been deposited is burnished bright with a piece of cotton wool and peroxide of iron, freshly precipitated by ammonia from a dilute solution of ferrous sulphate. The cost of silvering is found to vary from 2d. to 4d. per inch diameter.

*(To be continued.)*

## SMALL SCREW GAUGE.

Report of the Committee, consisting of Sir W. H. PREECE (*Chairman*), Lord KELVIN, Sir F. T. BRAMWELL, Sir H. TRUEMAN WOOD, Major-Gen. WEBBER, Col. WATKIN, Messrs. CONRAD W. COOKE, R. E. CROMPTON, A. STROH, A. LE NEVE FOSTER, C. J. HEWITT, G. K. B. ELPHINSTONE, T. BUCKNEY, E. RIGG, C. V. BOYS, and W. A. PRICE (*Secretary*), appointed to consider means by which Practical Effect can be given to the Introduction of the Screw Gauge, proposed by the Association in 1884.

IN the year 1882 a Committee of this section was appointed to determine a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes. This Committee reported to the section in the succeeding years 1883, 1884, and proposed that a certain system of screw threads, since known as the British Association screw threads, should be recommended for adoption by users of small screws in this country. The system is identical except in one small point with that used in Switzerland and associated with the name of Prof. M. Thury. The series consists of 26 threads, numbered 0·25, having diameters from 6 mm. down to ·25 mm., and is so closely graduated that only in exceptional cases can any size be required intermediate between two of the set. The form of the thread has proved to be well adapted for practical purposes, and screws made on this system have come into extensive use among English manufacturers of small mechanical apparatus. It has been adopted by several Government Departments, who have imposed its use upon their contractors.

In the year 1895 representations were made to the section, and some correspondents of the technical papers urged, that the value of this system was prejudiced by the fact that purchasers of British Association screws and screwing tools could not rely on obtaining from manufacturers goods which were interchangeable with one another. This raised at once a question which had not been closely considered by the 1882 Committee—viz., the mode of determining whether any given screw of a particular number is or is not a fair representation of the form laid down by the British Association specification. The present Committee were appointed at the Ipswich meeting to deal with this point, and with some additional members have sat at intervals up to the present time.

In 1896 an interim report was presented to the section at the Liverpool meeting, in which the problem of the mode of gauging small screws was discussed at length. The principal conclusion reached at that time was that as no means exists of examining a nut or female screw, the efforts of the Committee should be directed to obtaining accurate plug or male screws for use as gauges, and combs or chasers.

During the three years that have elapsed since this report was made the Committee have been in communication with different firms, and principally with the Pratt & Whitney Company, of Hartford, U.S.A., a firm enjoying the very highest reputation for work of the kind the Committee desired to secure. Finding that this firm were prepared to undertake the production of gauges and tools for the British Association screw-threads on the same lines as they have adopted with the American and Whitworth threads, the Committee have been satisfied to leave the matter in the hands of the company till they should ascertain whether they could produce the desired result, and have given them all the information, specifications, &c., that were possible. Within the last two months the Pratt & Whitney Company have submitted to the Committee specimens in hard steel of male and female gauge pieces of threads Nos. 3, 7 and 13. The three male screws of these sets have been photographed by Colonel Watkin on a large scale, and have been measured by Mr. H. J. Chaney, Superintendent of the Standards Department of the Board of Trade. Their two reports are printed below.

The Committee believe these gauges to be sufficiently accurate for practical requirements. The material of which they are made—hardened steel—should enable them to stand much use without injury. Their finish and general workmanship are exceedingly good.

The Committee, through their secretary, have expressed to the Pratt & Whitney Company their satisfaction with the progress made with these gauges, and have been informed in reply that a higher degree of accuracy may be expected in the future. They are still in correspondence respecting the specifications of limits of error and other details concerning their production on the commercial scale. The manufacture and sale of these gauges by the Pratt & Whitney Company appear to realise the object set before themselves by the Committee, viz., to assist the extension of the use of the British Association system of screw threads by making generally available accurate means for their verification.

While recognising the excellence of the form of the British Association screw-thread for mechanical purposes, the Committee feel strongly that the difficulty of producing the form to the degree of accuracy desirable for the best class of work, and especially for gauge pieces, is a serious drawback to its value. Colonel Watkin's photographs show very clearly that the best appliances in the most experienced hands that the Committee could find have failed to produce even single specimens of first-rate accuracy. The letters addressed to the secretary of the Committee by Mr. George M. Bond, manager of the standards and gauge department of the Pratt and Whitney Company, as well as the high reputation of his firm, leave no room for doubt that very great care has been taken to secure accuracy in these specimens. A considerable number of gauges made by English firms of good standing have been examined by the Committee, and have in every case shown errors of the same character as, though usually to a much greater degree than, the specimens submitted by the American firm.

From several sources, and especially in Mr. Bond's letters, it has been urged on the Committee that although the difficulties of constructing these gauges of a very high degree of accuracy are practically insuperable, screw-threads of a flat-anded form can be produced with great exactness. A photograph taken by Colonel Watkin of a fine screw taken from an instrument made by Messrs. Brown & Sharpe shows that this is certainly the case.

The American, or flat-ended, form of thread appears to be rapidly establishing itself in France and Germany, judging from the reports we have received of the French and Zurich Conferences, and we understand that it is entirely employed by the French Admiralty and by several of the French railway companies. These reports refer, it is true, to screws of larger sizes than are included in the range of the British Association and Prof. Thury's systems. The conclusions of the recent Conference at Zurich, which adopted the flat-ended thread, were expressly limited to screws of more than 6 mm. diameter, the extreme upper limit of our system. But so far as the easy production of accurate form is concerned, arguments which apply to large screws apply with greater force to small screws; while a form which is suitable for all screws above 6 mm. cannot be wholly unsuitable for screws below that limit. The Committee, moreover, were informed by one of their number, that he has used screws of the American form in sizes corresponding with some of the smaller numbers of the British Association series, and has found them perfectly satisfactory.

Current conceptions of the possible and desirable limits of accuracy in mechanical construction are rapidly advancing, and while we recognise the value of the work of the Committee of 1882 in establishing a generally accepted thread, we are dissatisfied with a standard form for a piece so important as a screw which is open to the serious objection referred to above.

We recommend that this Committee shall be reappointed for the purpose of considering whether the British Association form of thread for small screws should be modified, and if so in what direction.

### APPENDIX I.

Report by COLONEL WATKIN, R.A., C.B.

The Wilderness, Woolwich,
*July 11th*, 1899.

The Secretary British Association.
Screw Gauge Committee.

I have now taken photographs of the screws sent by the Pratt and Whitney Company for the Committee, prints of which I enclose.

I find the general forms of these screws are better than those we have obtained heretofore, which is satisfactory, taking into consideration the fact that they are constructed of hard steel.

As in former cases, the larger sizes conform more nearly to the British Association pattern thread, the rounding in the smaller sizes being not quite so satisfactory.

The angle of the thread in the two large sizes is about 49°, but considerably more in the No. 13 size.

As regards linear dimensions, all the screws are nearly perfect, as will be seen by the measurements given on the back of the photographs.

The diagonal scale accompanying the photographs was constructed from the scale photographed at the same time as the screws.

The gauges may, I think, be accepted as sufficiently correct for all practical purposes as standard gauges for British Association pattern screws.

(Signed) W. Watkin.

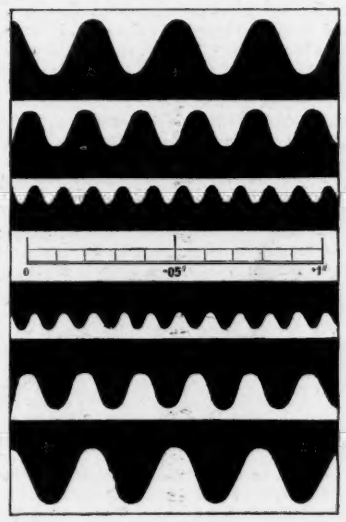


Fig. 1.—Reproduction of three Photographs referred to in Colonel Watkin's Report, superimposed on one another.

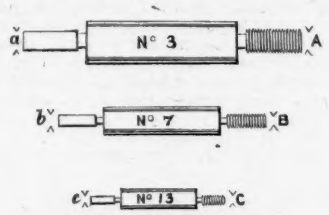



Fig. 2.

## APPENDIX II.

Report from Mr. H. J. Chaney, Superintendent of the Standards Department of the Board of Trade.

Standards Department, Board of Trade,

*July* 10*th*, 1899.

My dear Sir,—I have now the pleasure to enclose, for the information of Sir William Preece, a statement showing the external dimensions of the three male screws which you forwarded to me on Thursday last, and which have been returned to-day by registered post. The dimensions were determined by contact comparisons (made by independent observers) of the screws with Board of Trade Standard cylindrical gauges, plane gauges, and wire gauges; and in the case of the smallest screw (c), by microscopic comparison with a linear standard.

Had time allowed, a more exhaustive examination of the three screws might have been made; but the present comparison may, I suggest, be relied on to ± 0·0001 inch. The dimensions given in the enclosed paper (4·1023 mm., 0·16151 inch, &c.) are in each case the mean external diameter of the whole length of the screw, and show that although A and C have perhaps appreciable errors, the required dimensions have generally been closely followed by Mr. Bond. The screw-threads are in fact, in our opinion, of excellent workmanship; but it is doubtful whether the screws are always perfectly cylindrical. For instance, the mean external diameter of the last eight threads of screw C (or the point of the screw) is 0·008 mm. greater than the external diameter of the 15 middle threads of C. The external diameter of the seven last threads (shoulder of the screw) of C agree in measurement with the diameter of the point of the screw.

I should much like to see a copy of Colonel Watkin's photographs.

Yours faithfully,

(Signed) H. J. Chaney.

W. A. Price, Esq.

Dimensions Specified.

| | | | | | |
|---|---|---|---|---|---|
| A | ... | ... | 4·1 | mm. | = ·16141 inch. |
| *a* | ... | ... | 3·224 | „ | = ·12693 „ |
| B | ... | ... | 2·5 | „ | = ·09842 „ |
| *b* | ... | ... | 1·924 | „ | = ·07575 „ |
| C | ... | ... | 1·2 | „ | = ·04724 „ |
| *c* | ... | ... | ·9 | „ | = ·03543 „ |

| Screws Nos. 3, 7, 13. | | Value in millimetres. | | | Value in inches. | | |
|---|---|---|---|---|---|---|---|
| | | Nominal. | Observed. | Difference. | Nominal. | Observed. | Difference. |
| 3 | A ... | 4·1 | 4·1023 | +0 0·23 | 0·16142 | 0·16151 | +0 C0009 |
| | *a* ... | 3·224 | 3·2304 | +0 0064 | 0·12693 | 0·12718 | +0 00025 |
| 7 | B ... | 2·5 | 2·5048 | +0 0048 | 0 09843 | 0 09862 | +0 00019 |
| | *b* ... | 1·924 | 1·9273 | +0 0033 | 0 07575 | 0 07588 | +0 00013 |
| 13 | C ... | 1·2 | 1·2015 | +0 0015 | 0·04724 | 0 04730 | +0 00006 |
| | *c* ... | ·9 | 9048 | +0 0048 | 0 03543 | 0 03562 | +0 00019 |

*July* 10*th*, 1899. (Signed) H. J. Chaney.

## ELECTROLYSIS AND ELECTRO-CHEMISTRY.

**Report of the Committee, consisting of Mr. W. A. Shaw (*Chairman*), Mr. E. H. Griffiths, Rev. T. C. Fitzpatrick, Mr. S. Skinner, and Mr. W. C. D. Whetham (*Secretary*), appointed to report on the Present State of our Knowledge in Electrolysis and Electro-Chemistry.**

*Section A.—September* 15*th*.

The conductivity of a number of salts in very dilute aqueous solution at the freezing point of water has been determined by Mr. Whetham, while Mr. Griffiths has concurrently made observations of the freezing point for corresponding solutions. The observations of conductivity extend to solutions of sulphuric acid, potassium chloride, sodium chloride, barium chloride, copper sulphate, potassium permanganate, potassium bichromate, and potassium ferricyanide. The range of dilution is, speaking generally, from below the hundred-thousandth to about the twentieth part of a gramme equivalent per thousand grammes of solution.

The water used was specially distilled three times, and finally from a platinum still, and collected in platinum vessels. Its approximate conductivity was about $1·1 \times 10^{-15}$ at 18° C. in C.G.S. units. The best water obtained by Kohlrausch by distillation in vacuo had a conductivity of $0·2 \times 10^{-15}$ in the same units at the same temperature.

The results obtained this year, while confirming those described at the last meeting of the Association for solutions of moderate concentrations, show differences when great dilutions are reached, but the constancy of the present measurements shows that the water now used is good enough to enable trustworthy values to be obtained even at the lowest limits of dilution above mentioned.

Mr. Griffiths has remodelled his apparatus for determination of freezing points, and is now able to carry the measurements of temperature to a higher degree of accuracy than hitherto.

As soon as the observations are completed, it is intended to publish the results of both investigations together.

No further progress has been made with the rest of the report.

## MUNICIPAL TRADING AND PROFITS.

By Robert Donald.

(*Read in the Economic Section, September* 15*th*.)

There should be no reason to object to municipal trading, from a commercial point of view, as the figures in a recent Government return show that an average annual profit on municipal water, gas, and electricity works, markets, tramways, and workmen's dwellings amounts to 4¼ per cent. on the capital invested.

The chief opposition to municipal trading last session of Parliament arose with electricity supply. It will be found that municipalities produce electricity at a lower cost and supply it at lower prices than do companies. A comparison between 21 municipal and 21 company undertakings, including in the latter the large London concerns and the companies of Birmingham, Leeds, and Sheffield, where the supply has been recently municipalised, gives the following result:—

Cost of production per unit—Municipalities, 1·87d.; companies, 2·71d. Average price per unit to consumer—Companies, 5½d.; municipalities, 4½d. Profit on mean capital—Companies, 7½ per cent; municipalities, 7¼ per cent.

Thus, municipalities produce electricity at ¾d. less per unit than companies, sell it at 1d. less per unit, and earn only ¼ per cent. less profit.

Municipalities as a rule supply gas of a higher illuminating power than companies, and at a lower price. A comparison between a representative number of municipal and privately managed gas works shows that the average price of the municipal gas is less by 3d. per 1,000 cubic feet, the candle-power is higher, and the average profit on capital employed only 1 per cent. less than that obtained by companies.

The direct operation of tramways by corporations has been done under easy conditions as regards capital expenditure, and has at once led to increased traffic. There has been a readier response to public demands, a reduction of fares, and better treatment of employés—all of which have combined to make municipal tramways very successful from a business point of view.

Municipal trading compares well with private enterprise. But it is not enough to show profits from municipal trading, as it is suggested that municipalities have no business to make profits. These are chiefly the people who would like the profits for themselves. But there are other reasons, based on economical grounds, why the aim of municipalities should be to provide the cheapest services at cost price rather than seek profit. The system of relieving general local taxation out of the surplus revenues of gas, water, tramway, and other undertakings has been necessary in order to demonstrate the business capacity of municipal bodies; but the policy is not one which best serves a community. When a town draws profit from gas, water, or electricity supplies, it is simply levying so much direct taxation on the users of these commodities for the benefit of the general community. The consumers might justly say that since the municipality became the sole providers of gas and electricity it deprived them of the advantages of competition, and should supply the cheapest possible article.

Whether municipalities should make a profit is left largely to their own discretion. It is becoming the practice not to make trading profits from water supply, and only a small margin of profit is sought on artisans' and labourers' dwellings and lodging houses. The practice of Parliament tends towards restricting profits. Profit from electricity supply works, for instance, is limited to 5 per cent. All surplus above that should be devoted to reducing charges. In Scotland, profit-making in connection with water or gas supplies is rendered impossible by the General Acts, which provide that surpluses go to reduce charges. No town has advanced so far in municipal organisation as Glasgow, and no town stands higher for the efficiency of its administration or the civic spirit of its citizens; and nowhere else, taken all round, are charges for municipal services so low; nor has any other town carried out so systematically the policy of little profit.

It will be found that in the towns where the civic spirit is the keenest and healthiest, where municipal institutions are most largely developed, there the profit sought is least and the administration is the best.

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## RADIATION FROM A SOURCE OF LIGHT IN A MAGNETIC FIELD.

Preliminary Report of the Committee, consisting of Prof. George Francis FitzGerald (*Chairman*), Thomas Preston (*Secretary*), Prof. A. Schuster, Prof. O. J. Lodge, Prof. S. P. Thompson, Dr. Gerald Molloy, and Dr. W. E. Adeney.

(*Section A —September 15th*)

The work undertaken by this committee has not yet terminated. This occurs partly from the difficulties which arose in obtaining a satisfactory supply of electric current with which to excite the powerful electro-magnet now in the hands of the committee, and partly from the circumstance that the secretary was not always free to work at such times as the staff of the Royal University found it convenient to permit research work in the Physical Laboratory.

Considerable advance has been made, however, during the past session, and the magnetic perturbations of the spectral lines of several substances have been observed and photographed from one end to the other of the spectrum. A considerable amount of work remains to be done in this direction still, and this we hope to complete in the near future.

The chief points of interest determined by the committee since its appointment are as follows:—

1. On Friday, September 9th, 1898, Prof. S. P. Thompson attracted the attention of the British Association (see "Brit. Assoc. Report, 1898," p. 789) to an elegant experiment devised by Prof. Righi for the purpose of illustrating the absorption of light in a magnetic field. This experiment was stated by Prof. Righi to succeed only when the light traversed the field along the lines of force, but it appeared to us from theoretical considerations that similar absorption should also take place when the light traverses the field across the lines of force. On trying the experiment on the following Tuesday (September 13th, 1898), it was found at once that the experiment was capable of demonstrating absorption across the lines of force * as markedly as that ascertained by Prof. Righi along the lines of force. This result was also ascertained subsequently, and independently, by M. Cotton.†

2. The next point of interest consisted in placing beyond doubt that the various modified forms of triplet, that is the quartets, octets, &c., are not produced by reversal or any other extraneous cause, but are true magnetic perturbations of the same kind as the normal triplet, which is to be expected from the simplest theoretical considerations. An account of the experiments by which this was determined will be found in the *Philosophical Magazine* for February, 1899, (*Phil. Mag.*, Vol. xlvii., p 165).

In pursuing this inquiry it was found that in a very strong magnetic field the quartets ultimately became resolved into sextets, the side lines of the quartets splitting up into pairs and separating as the strength of the field gradually increased.

These quartet forms, and various other types of perturbation, were observed by Mr. Preston in the beginning of November, 1897, and were shown at the following meeting of the Dublin University Experimental Science Association. Subsequently the quartet form (which we have now proved in the cases observed to be really a sextet) was independently observed by M. Cornu* and others.

3. Finally, from the various observations of the character and measurements of the amount of the magnetic effect experienced by the various spectral lines of several substances, a general law has been inferred concerning the effect, which may be stated as follows:—†

1. The spectral lines of a given substance may be divided into groups such that all the members of one group suffer the same kind of perturbation in the magnetic field, but the kind of perturbation of all the members of another group is different. Thus, for example, in the series of triplets of zinc, the first of one triplet is similarly affected to the first of each of the other triplets, while the second of one triplet is affected in the same way as the second in each of the other triplets, but in a different way from first and third of the triplet. Hence the series of firsts of each triplet constitute a group all the members of which are similarly affected, and the series of seconds and thirds are other such groups.

2. The character of the effect is the same in the corresponding lines of the spectra of chemically related elements. Thus, the triplets of cadmium are affected in the same way, both as regards the character and the magnitude of the effect, as are the triplets of zinc.

3. In any one group the magnitude of the effect is inversely as the wave-length of the line.

Further information will be found in this connection in the *Philosophical Magazine*, Vol. xlvii., p. 165, February, 1899, and the *Phil. Trans. Royal Dublin Society*, Vol. viii., Series II., p. 7, 1899.

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## ON THE THEORY OF THE ELECTROLYTIC SOLUTION PRESSURE.

By R. A. Lehfeldt.

(*Abstract, Section A, September 15th*)

According to Nernst's theory, when a metal is immersed in an electrolyte, a minute amount of it goes into solution in the ionic form, giving a positive charge to the liquid as compared with the metal, or ions from the solution are deposited in metallic form, giving the metal a positive charge according as the osmotic pressure of the ions in solution falls short of, or exceeds an amount known as the electrolytic solution pressure. This view has been generally adopted by physical chemists, it being supposed that the amount of metal to be deposited or dissolved is too small to measure. By combining the calculated value of the solution pressures with the known theorems of electrostatics on the tension exerted by electric charges, it may be shown, in the case of zinc at least, that the amount dissolved would be some centigrammes per square centimetre immersed, and could easily be weighed. Hence the theory seems to break down.

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## ON THE PRODUCTION, IN RAREFIED GASES, OF LUMINOUS RINGS IN ROTATION ABOUT LINES OF MAGNETIC FORCE.

By C. E. S. Phillips

(*Abstract, Section A, September 15th*)

The apparatus used in this investigation consisted of an approximately spherical glass bulb, the ends of which were left open for the purpose of inserting two soft iron electrodes, half an inch in diameter, through air-tight flanges which themselves were cemented to the glass. The bulb was about 2½ inches in diameter, and the electrodes were chosen of a sufficient length to enable them, while almost meeting at the centre of the bulb, to project outwards slightly beyond the rims of the flanges. A side tube was attached for the purpose of connecting the apparatus to a Sprengel air-pump and McLeod vacuum gauge. Two powerful electro-magnets were then adjusted, so as to strongly magnetise the electrode when necessary.

A low pressure having been produced in the bulb by the action of the air-pump, leading wires were attached to the iron electrodes to enable the discharge from the secondary of an induction coil to be passed through the rarefied gas. Under these conditions the effects produced in the usual glow-discharges by the magnetisation of the electrodes could be conveniently examined. It was seen that at a pressure represented by ·008 mm. of mercury, and with the discharge just able to pass in the bulb (the magnets meanwhile remaining unexcited), on shutting off the current from the induction coil and completing the magnet circuit, a luminous ring appeared within the bulb in a plane at right angles to the lines of force and in rotation about the magnetic axis. The number of such rings can be varied by special devices, and their brightness largely depends upon the electrostatic condition of the outer surface of the glass bulb. The circumferential speed of the ring or rings rapidly dies down, and the sense of the rotation reverses when the magnetic polarity of the electrodes is reversed. The rings, when once formed, usually last for many seconds, sometimes for a minute; and they momentarily brighten before disappearing, when the electrodes cease to be magnetised. The appearance of the rings is greatly affected by bringing charged bodies up to the outside of the bulb.

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* See *Nature*, lix, 228-9, January, 1899.
† *Comptes Rendus.*

* *Comptes Rendus.*
† This law was published in *Nature*, lix., 248, January 12th, 1899.

The effect also depends upon the manner of stimulation of the rarefied gas within the bulb. It is necessary to obtain a particular distribution of charged particles in order to get the best results when the magnet is excited. The shape of the magnetic field is also of importance. A single magnetic electrode projecting into the electrified gas shows the effect fairly well. Experiments with external magnetic electrodes have not given reliable results, the glow produced in such cases being generally irregular. An attempt will be made later on, when the experiments are more complete, to show that the formation of these luminous rings is associated with actions observed by the writer in connection with a separate research, the results of which were embodied in a note communicated to the Royal Society last June under the heading "Diselectrification produced by Magnetism."

## DURBAN CORPORATION TRAMWAYS.

DURBAN is a little one-horse show in Natal. Its population is 40,000 and, at this, one half is native or coloured. Yet Durban is better placed than London, for it possesses apparently a City Council of infinitely greater intelligence, and it employs three men of decision to advise it as regards its electrical tramways. These three men are the borough engineer, Mr. J. Fletcher; his assistant, Mr. Crawford Lindesay; and the electrical engineer, Mr. John Roberts. The latter two were deputed to come home and examine tramways in England and America. They did so. They came and saw and went back to their one-horse little town, and they reported strongly in favour of an electrical system with overhead construction. Evidently Durban had instructed them that better tramways were wanted, and they were desired to go forth and find the best system.

They report like men. There is no evidence whatever that these men have acquired the professorial art of sitting on a fence. They don't say two things at once, so that in 10 years' time they can gracefully point to their report and say, "We told you so." But they study the question thoroughly and come to a firm decision and put this down like men in plain black and white, and their report jointly with that of the borough engineer—another man—makes over 100 pages of sound, healthy reading. They have seen innumerable electrical tramways and have got such a grip and insight of their subject as seems to show that their visit home was really intended as a means towards providing Durban at once with the best present system of tramways. If Durban does not follow the advice of its three engineers, no blame can attach to the engineers.

The authorities of Durban cannot go to the public and say "our engineers have advised us to adopt an impossible system." Now in this our City and County of London, our unfortunate County Council having first made up its mind to hinder all progress of a useful order, had no difficulty in getting an engineer to report to them on American tramways, and Prof. Kennedy, having acquired a thorough knowledge of that little country, the United States, during a prolonged visit of a fortnight, issued his report. We have published this report, and would refer our readers to it. We wish we could publish that of these Durban engineers, because there is something to learn from it. One particularly striking passage occurs. It is a reference to the obstructive action of English authorities. Clearly these travelling engineers are the servants of a more progressive municipality than most of our English towns possess. They condemn also the unnecessary ugliness of American poles and overhead work. They advise top seat cars which they have seen in England run on steeper gradients in Halifax and Bradford than the maximum grade which obtains for only a short distance in Durban, viz, 1 in 13.

We consider this report to be a masterly production, and one of the kind that ought to be submitted to the more or less non-technical councillor. There is not an overburden of argument, but sufficient to justify the very definite conclusions arrived at. The council has been provided, not with a dilettante discussion on vague generalities, but with plain straightforward advice from its advisers. Evidently, in South Africa, the use of an adviser in technical matters is to clear the ground and settle the minds of the authorities and pave the way for progress, not to throw a halo of fog round the subject and suggest possibilities, probabilities, and impossibles. The engineers might have advanced some pet scheme of their own, but they have advised what can be best bought in open market, and have not saddled their ratepayers with unnecessary expenses, to the ruin of all progress.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

17,815. "Improvements in direct acting electric generators and in directly driven electric compressors for air or other gases." J. ATKINSON. Dated September 4th.

17,846. "Improvements in or connected with electric motors and generators and other electric apparatus and instruments." V. A. FYNN. Dated September 4th.

17,857. "Improvements in galvanometers and electrical indicating and signalling apparatus." A. W. TOURNAY-HINDE. Dated September 4th.

17,877. "An improved composition of or from which may be manufactured tubes for various purposes, tyres and other articles requiring more or less flexibility, or as a non-conductor of electricity." G. BESTWICK. Dated September 5th.

17,878. "An improved composition of or from which may be manufactured billiard balls, handles for umbrellas or sticks, electric buttons and other articles of a like nature and general utility, and as a substitute for mica." G. BESTWICK. Dated September 5th.

17,924. "A new or improved process and apparatus for electrolytically precipitating metals in the cementation vats." A. ROVELLO. Dated September 5th. (Date applied for under Patents, &c., Act, 1883, Section 103, March 16th, being date of application in Italy.)

17,938. "Electro-medical batteries." C. J. MARIUS. Dated September 5th. (Complete.)

17,989. "Improvements in electric rock drills." G. BARKER. (S. Lesem. United States.) Dated September 5th. (Complete.)

17,953. "Improved means and appliances connected with air tight electric arc lamps." J. J. RATHBONE. Dated September 5th.

17,998. "Improvements in electrical switches." B. THOMAS. Dated September 6th.

18,005. "Improvements in secondary galvanic batteries or accumulators." R. N. LUCAS and E. S. NEW. Dated September 6th.

18,013. "Improvements in field magnet cores for electric motors or generators of enclosed type." H. W. WILSON. Dated September 6th.

18,014. "A new and improved apparatus for the intermittent lighting of electric lamps or groups of lamps for advertising purposes and the like." W. J. PARTRIDGE, F. T. LOVE and C. T. POUNSFORD. Dated September 6th.

18,028. "Improvements in electrical switches." G. W. HOLT and A. ATHERLEY. Dated September 6th.

18,040. "Improvements in or relating to telephone speaking tube and like receivers." H. A. CUTMORE. Dated September 6th.

18,064. "Improvements in electric trolley standards." C. W. G. LITTLE and A. J. IRELAND. Dated September 7th.

18,094. "A coin-freed electricity meter." G. A. MAQUAY. Dated September 7th.

18,100. "Improvements in electrical batteries." R. PEARSON. Dated September 7th.

18,124. "A new or improved method and means for electrically illuminating advertising signs and the like." F. M. STAUNTON. Dated September 7th.

18,131. "Improvements in electric arc lamps." P. MERSCH. Dated September 7th.

18,133. "Improvements in clocks, more particularly in electric winding mechanism therefor." F. I. GETTY. Dated September 7th.

18,138. "Improvements relating to electrical resistance boxes and like apparatus." T. E. GAMBRELL and C. T. GAMBRELL. Dated September 8th.

18,143. "An improved conical shaped collar reflector for the incandescent electric lamp by means of which the light is reflected and diffused and advertisements displayed." C. BUCKTON, G. E. FLETCHER and H. FLETCHER. Dated September 8th.

18,159. "Improvements in automatic telephone exchanges." W. AITKEN. Dated September 8th.

18,173. "Improvements in telephonic systems and in apparatus therefor." M. BYNG and F. G. BELL. Dated September 8th. (Complete.)

18,200. "Improvements in or connected with ships' telegraphs." D. KENNEDY. Dated September 8th.

18,254. "Improved construction of accumulator plates." E. T. A. POLZIN. Dated September 8th.

18,266. "Improvements in electrical resistance and heating apparatus." S. BRAMALL and J. T. ARMSTRONG. Dated September 9th.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

#### 1898.

**2,106. "Improvements in and connected with electric arc lamps." J. O. Girdlestone and C. F. G. Thorkelin.** Dated January 26th, 1898. Consists in a central tube passing into the body of the lamp and containing the upper carbon holder which slides on rollers in this tube. 4 claims.

**3,316. "Improvements in a self-restoring annunciator more particularly suitable for employment in connection with telephone switchboards." J. E. Kingsbury and the Western Electric Company.** Dated February 9th, 1898. Consists in combining an annunciator drop with perforated parallel plates supporting the drop at each end. 6 claims.

**7,193. "Improvements in or relating to primary batteries for producing electric currents also applicable for the purification of water." A. J. Boult. (J. Cerpaux and Wilhaux.)** Dated March 24th, 1898. Relates to improvements in primary electric batteries. The polarising liquid is rain or salt water. Consists in a combination of a column of broken graphite in contact with conducting bodies and surrounded by a fabric jacket with a sectioned zinc cylinder, the column and the cylinder being maintained at the desired distance apart by two covers of non-conducting material. The covers have recesses to fit the fabric jacket. 8 claims.

**7,575. "Improvements in electric furnaces for manufacturing calcium carbide." W. P. Thompson. (C. L. Wilson, C. Muma, J. W. Unger, H. Schneckloth, A. P. Brosius, and J. C. Kuchel.)** Dated March 29th, 1898. Consists of a hollow electrode having at its upper end an insulator which is provided with openings to communicate with the openings in the electrode. Means are provided for raising or lowering the electrode and insulator so that it may be fed by hand. 2 claims.

**7,725. "Improvements in holders for incandescent electric lamps." J. M. Heisman and H. C. Gover.** Dated March 31st, 1898. Relates to holder for incandescent electric lamps. The holder is well insulated and has two spring push contacts. 1 claim.

**9,047. "Hanger for trolley wires of electric railways." W. A. McCallum.** Dated April 19th, 1898. Relates to hangers used to suspend the ears carrying the trolley wire from the cross wires. Consists in providing the hanger cap and the point of the insulated bolt with oppositely cut threads, also the inner surface of the hanger cap and the upper surface of the insulated bolt with suitable indentations and interposing between them compressible washers. 2 claims.

**16,155. "Improvements in the globes of electric incandescent and similar lamps and lamp shades or chimneys." English Industrials Ltd., and G. E. H. Dia.** Dated July 25th, 1898. Consists in moulding the inner surface of the glass object on the prismatic principle, *i.e.*, with prisms arranged in hexagonal groups over the entire surface. 3 claims.

**16,875. "Improvements in electricity meters." E. Schattner.** Dated August 4th, 1898. Consists in the employment of a pivoted balanced lever in connection with a voltmeter of some suitable type, the passage of the current through the

voltmeter being arranged to alter the weight upon one end of the lever so that the amount of current consumed may be found by obtaining by a moving weight a balancing point for the lever, such point being read off on a suitably situated scale. 3 claims.

**17,260. "Improvements in electrically driven fans or ventilating devices." S. Bergmann.** Dated August 10th, 1898. Relates to an electrically driven fan so constructed that the driving electromotor is rotated around a vertical axis by the reaction of the air whereby a second set of vanes is set in motion and a more active churning of the air is effected. 3 claims.

**21,241. "Improvements in telephone switchboards." F. M. Richter.** Dated October 8th, 1898. Relates to telephone switchboards. Consists in lifting or returning and re-engaging the annunciator flap. The flap falls down at a call and the operator inserts a plug in the sleeve and raises the flap by the thrust against a lug and it is held by the armature. Simultaneously a contact spring is lifted from another. After the conversation the subscribers make contact for energising the electro-magnet, thus again releasing the flap. The operator then pulls the plug out and the flap is raised in the same way as when the plug was inserted. 1 claim.

**21,841. "Improvements in the armatures of multipolar dynamo-electric machines." Siemens Bros. & Co., Limited. (R. Dumas and G. S. Grimston.)** Dated November 1st, 1898. Relates to construction of the armature and means in fixing the core plates in such a manner that they are held firmly in opposition to the centrifugal force when the armature revolves at high speed. The core plates are fixed to the arms of the armature by making the arms with laterally projecting dovetails radially dividing the arms engaging on them the dovetail notches of the core plates. The divided arms are widened out by driving wedge keys between the divided parts. 2 claims.

**21,942. "Improvements in electrical contact breakers." R. Haddon.** (Allgemeine Electricitats Gesellschaft.) Dated October 18th, 1898. Relates to mercury contact breakers where the conductor is fixed and the mercury is given the required movement. The conductor has the form of a ring or cylinder and is provided with one or more slots at its lower edge. Against this part of the conductor a stream of mercury is excited rotating round within the ring. The mercury ejection is obtained by the rotation of a tube bent at right angles, one arm of which is vertical and lies in the centre of the ring and dips into the mercury, whilst the other, which is horizontal, rotates round and on the former. The slotted ring and this horizontal tube lie in an insulating liquid with which the mercury is covered. As soon as the speed of rotation has reached a certain point, the mercury is drawn up by the centrifugal force created, and is ejected through the horizontal arm. When the metal ring forms one pole and the mercury the other of a conduct, the circuit is alternately interrupted and closed. 4 claims.

**22,085. "Improvements relating to conductors and collectors for electric railways." C. H. Myers.** Dated October 20th, 1898. Relates to improvements in electric railways. In combination with the conductor rail is a sectional boxing arranged to partially enclose the rail and having its side movable away from said rail and means for locking the sides of the boxing in place. The boxing has a slot to allow the trolley traveller to have access to the conductor rail. 7 claims.

**22,601. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (H. C. Spinney.)** Dated October 27th, 1898. Relates to improvements in the construction of arc lamps. Consists of a combined cap support and floor for a clutch, also means for maintaining it at a fixed distance from the lamp mechanism, and means for permitting the support to have practically a universal motion for the purpose of adjustment. 15 claims.

**22,683. "Improvements in couplings for electric conductors." The British Thompson-Houston Company, Limited. (F. E. Case.)** Dated October 28th, 1898. Consists in making a half-lap joint of the two ends of the conductor, and fixing them together by screws in long holes or slots. 4 claims.

**22,864. "Improvements in plug switches or wall contacts for electric circuits." A. Vandam and T. H. Marsh.** Dated November 1st, 1898. Relates to plug switches having concentric terminals. Consists of an insulating piece composed of an inner tubular portion and an outer partially tubular portion provided with projections for supporting a fuse wire. 2 claims.

**23,243. "Improvement in and relating to electric accumulators." P. Ribbe.** Dated November 4th, 1898. Relates to a rib plate for accumulators. In the plate are cross ribs standing at an oblique angle to the surface of the plate and issuing on both sides, from a core plate which runs through it. 2 claims.

**23,546. "Process for obtaining an electrolytic deposit of metallic films on aluminium." O. T. Nanhardt.** Dated November 8th, 1898. Relates to a process for obtaining an electrolytic deposit of metallic films on aluminium, and the main object of it is to prevent the bath from attacking the aluminium, and thus to obtain a good and throughly adherent coating or film upon its surface. The baths employed have eliminated from them the caustic or acid properties which attack the aluminium by neutralising such baths by adding to them derivatives of phosphorus, and more particularly by a proportionate addition of ammonium phosphate. 1 claim.

**23,716, "Improvements in or relating to secondary or storage batteries." R. Haddon. (G. J. Miller).** Dated November 10th, 1898. The plates are stamped to form the recesses. Consists of an insulating cell containing two metallic electrodes each of which comprises an inner metallic core adapted to receive and retain the active material, perforated metallic envelopes surrounding said core piece. These envelopes have mechanical and electrical contacts with either respective cores, and a perforated insulating piece between the envelopes of respective electrodes. 13 claims.

**24,171. "Improvements in voltaic cells having dry plates which may be regenerated." H. Schloss.** Dated November 16th, 1898. Relates to voltaic cells the plates of which are saturated with sulphuric acid and then dried so as to form the electrolyte when water is added. Consists in applying a coating of water glass to the surface of the plates as a protection against damp. 1 claim.

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## 1899.

**98. "Improvements in supports or crossovers for overhead electric conductors." J. M. Anderson and A. Andersen.** Dated January 3rd, 1899. Relates to electric conductor supports for overhead conductors. Comprises an insulating disc provided with a circular slot, a plurality of conducting arms extending from the disc and provided with projections to engage the slot and means for securing them to the disc. The arms are suitably insulated. 8 claims.

**101. "Electrodes for storage batteries." T. A. Willard.** Dated January 3rd, 1899. Relates to electrodes for accumulators. Consists in having a tubular electrode open at both ends and having leaves uniform in cross section and uniformly spaced from each other running spirally up it. 4 claims.

**102. "Means for producing battery electrodes." T. A. Willard.** Dated January 3rd, 1899. Relates to a machine which will make leaves from the surface of metal plates. Consists of a table and means to support and lock a flat plate to the table, a sharp edged cutter having its cutting edge at an angle to the plane of the plate and gradually deepening from front to rear and means to operate the cutter on the plate at varying distances apart at fixed intervals. 6 claims.

**287. "Improvements in cooling appliances for alternating current and rotary phase current motors." Siemens Bros. & Co., Limited. (Siemens & Halske, Aktien-Gesellschaft.)** Dated January 5th, 1899. Consists of combining with the end surfaces of the motor casing and guiding shields arranged to operate in conjunction with fan blades at the end surfaces of the rotor so as to produce air currents directed radially outward from the central air inlets which keep the whole apparatus cool. 2 claims.

**626. "Improvements in or connected with telephonic instruments." A. L. Baird. (T. Barnet.)** Dated January 10th, 1899. Relates to improvements in apparatus for recording the duration of time the telephone is used by the subscriber. The lever switch of the telephone is connected with a clock or other mechanism which will be inoperative when the telephone is in use. The up and down movement of the lever switch winds up the clockwork, thus making it automatic. 7 claims.

**907. "Improvements in transmitting printed telegraphic messages." A. Silbermann.** Dated January 14th, 1899. Relates to printing telegraphic messages. Consists of apparatus comprising a system of toothed printing and stop wheels which on receipt of impulses of current of either kind the letter to be printed comes opposite an electro-magnet so that on a further impulse of current being sent, whilst the whole system is at rest, the letter is impressed, the system then automatically reassuming its original position. 6 claims.

**925. "Rotary converters for single-phase alternating currents." M. Deri.** Dated January 14th, 1899. Consists of a rotor like a continuous current dynamo armature connected on the one hand with a collector, on the other hand with contact rings, and rotating within an iron stator provided with short circuit winding and also with exciting windings to produce by means of continuous current a constant magnetic field, which by co-acting with the armature keeps the armature in synchronous rotation. 2 claims.

**1,208. "Improved system of conduits for the underground conductors of electric railways." A. Sterzo.** Dated January 18th, 1899. Relates to the conductor for rail traction. Consists of a rail with an internal chamber containing the conductor, consisting of two parts; a simple rail having a wide basis with grooves and openings for the flowing out of water and the discharge of filth and a piece provided with ebonite bearings and binding screws to support the conductor. There is small opening between rail and piece to allow the passage of the rod connected to the motor. 2 claims.

**1,232. "Process and means for transforming electric currents." H. P. J. J. Thomsen.** Dated January 18th, 1899. Relates to improvements in transformers. Consists of an accumulator battery having groups of cells arranged in series is connected by shunt circuits from each group to a suitable commutator so that the elements come into action successively, either separately or in small numbers, and thus produce a current of correspondingly low tension obtained in succession from the whole set of batteries. 3 claims.

**1,324. "Improvements in and in the manufacture of electrode plates for electric accumulators." W. P. Thompson. (The Accumulatoren und Elektricitats-Werke, A. G. Vorm, and W. A. Boese & Co.)** Dated January 19th, 1899. Relates to electrode plates having as large a lead surface as possible and a very effective arrangement of the active mass and electrolyte. The plates are made with small flat formations of triangular shape placed alternately with their flat sides to one another in such a way that the points may in some cases be truncated, correspond to a similar position of the bases of the next layer, and when placed side by side present a latticed work or grid. 2 claims.

**1,334. "Improvements relating to electrically illuminated signs or advertisements." W. L. Campbell.** Dated January 19th, 1899. Consists of combining electrically illuminated signs or advertisements and the circuits thereof, and the automatically rotated snail cam or its equivalent, the peripheral contact it carries, and in constant electrical connection with the source of current, and a series of contact springs which illuminate the advertisements on the side of their particular box as the cam revolves. 5 claims.

**1,663. "Improvements in and relating to arc lamps." J. Molzer, F. Haffner and M. Kech.** Dated January 24th, 1899. The object of the invention is to provide a combined lamp and motor, the motor to drive a fan. Comprises lamp mechanism, a motor, an electric switch, electric connections for the motor and lamp, having in their circuits electric contacts and a switch lever provided with contacts so arranged that either the motor or lamp can be used alone or together. 19 claims.

**2,174. "An improvement in commutator brushes for electrical machines." Siemens Bros. & Co., Limited, and A. Siemens.** Dated January 31st, 1899. Relates to the construction of commutator brushes. The brush is made in one or more sections fitted in a suitable frame. Each section is pressed by an adjustable spring on the commutator and separately removable from the frame. 1 claim.

**2,175. "Appliance for automatically regulating the frictional pressure on the rails of the driving wheels of electrically propelled vehicles." Siemens Brothers & Co., Ltd. (Siemens & Halske Aktien Gesellschaft.)** Dated January 31st, 1899. The frictional pressure is obtained by means of an electro-magnet included in the circuit of the motor, so that the pressure is regulated by the strength of the current working the motor. 2 claims.

**2,288. "Improvements in or relating to accumulator plates." P. F. Ribbi.** Dated February 1st, 1899. Relates to an accumulator plate in which the active material is inserted in a perforated lead plate and is prevented from falling out by insulating plates covering the lead plates. 2 claims.

**2,299. "Improvements in the manufacture of electric accumulators or secondary batteries." J. G. Hathaway.** Dated February 1st, 1899. Consists in grouping two or more couples, each comprising a positive electrode active material arranged between them, and a porous support, a negative electrode and active material arranged between the same and a temporary support destructible by the acid and then rendering the negative active material self-supporting by "forming" the battery before the supports are destroyed. 6 claims.

**2,325 "Improvements in electric switches." C. Furer, M.D.** Dated February 2nd, 1899. Relates to contact making and breaking switches. The switch consists of a double lever of insulating solid material carrying at one end the connecting and at the other the disconnecting button and also a thin wedge-shape insulating tongue which in one action is pressed between the contact springs and in the other drawn out. The whole switch is covered with an elastic covering on which you press to actuate the switch. 3 claims.

**2,358. "Improved arrangement for exciting the magnets of dynamo electric machines." M. Deri.** Dated February 2nd, 1899. Relates to Specification 15,203, 1898. Consists in providing the periphery of the field magnets presented to the armature with compensation coils that are as uniformly arranged as the armature windings for the purpose of preventing sparking. 1 claim.

**2,396 "Improvements in and relating to the fixing of insulators for carrying electric line wires." H. Fleischhacker.** Dated February 2nd, 1899. Relates to the fixing of insulators for the purpose specified. Consists of improvements in the stem or holder of such insulators by means of which they may be fixed into stone, brick, or other walls with less likelihood of their becoming detached therefrom through oxidation of the stem. 1 claim.

**2,654. "Improvements in electric switches." E. L. Joseph.** Dated February 6th, 1899. Consists of a pivoted arm carrying a contact-piece adapted to make contact with two conductor terminals and acted upon by a spring in such manner that the contact piece is moved into and held in the open position at such a distance from the terminals as will effectually prevent sparking. 3 claims.

**2,745. "Improvements in conduits for electric wires or cables." E. H. Callaway.** Dated February 7th, 1899. Consists in making the conduits of baked clay joined by couplings of the hollow cylindrical type, and the whole is enclosed in a casing for protection. The conduits are exhausted of air. 4 claims.

**2,825. "Signals to indicate the approaching exhaustion of the carbons in electric arc lamps." E. A. Claremont and F. H. Royce.** Dated February 7th, 1899. When the carbons are nearly exhausted the machinery of the lamp makes an electrical contact which causes a visible signal to operate. 6 claims.

**2,956. "An improvement in apparatus for controlling electric motors." Siemens Bros. & Co., Limited, and J. G. Wilson.** Dated February 8th, 1899. Relates to Specification No. 12,088, 1897. Consists in combining with the revolving commutator controlling electric motors described in the above specification, sparking switches revolving with the commutator. 1 claim.

**2,971. "Improvements in arc lamps." H. J. Bagley.** Dated February 10th, 1899. Consists of an arc lamp produced in a vacuum or neutral gas which is produced in the same way as in incandescent globes. 1 claim.

**2,994. "Improvements in and relating to electric arc lamps." P. Rzepka.** Dated February 10th, 1899. Relates to a protection for the carbon holders against the arc when the carbons are consumed. Consists of a refractory ring or collar attached to one or both of the carbons. The rings are in two halves and are clipped together by a spring clip. 1 claim.